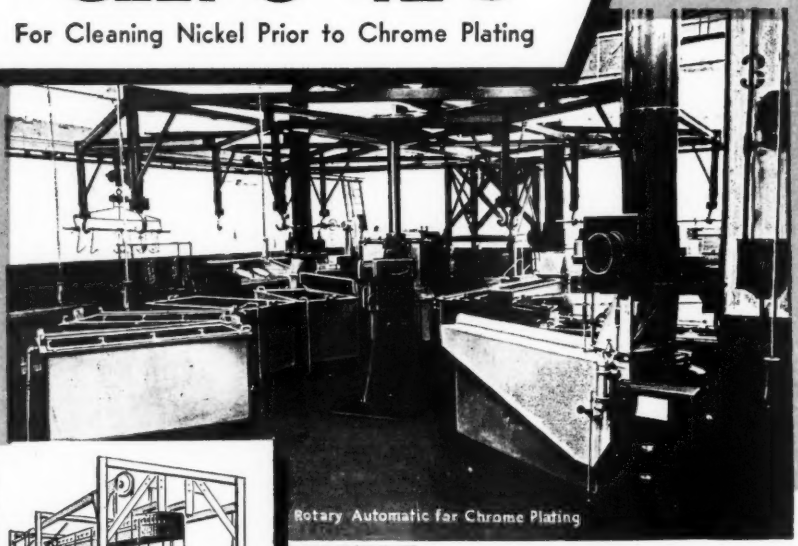
THE MONTHLY

Review

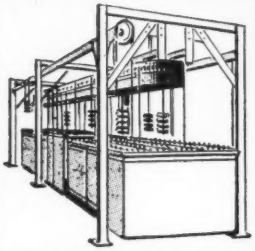
SEPTEMBER • • • 1946

CLEPO 42-S

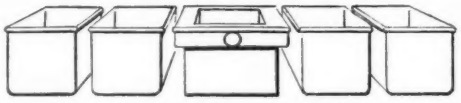
For Cleaning Nickel Prior to Chrome Plating



Rotary Automatic for Chrome Plating



Straight line return conveyor for Chrome Plating



Hand operated Chrome tank installation

CLEPO 42-S

for cleaning Nickel prior to Chrome Plating gives fast positive removal of buffing compounds and activates nickel surface so that subsequent Chrome plating has increased throwing power and the Chromium deposit is Free from stains.

Special cycles using Clepo 42-S have been developed for either hand operation or for automatic conveyors.

Send for Clepo Technical Data Sheet for full operating instructions. A request on your company letterhead will bring this important information to you immediately.

CLEPO — CLEANING COMPOUNDS

FREDERICK **GUMM** *Chemical Company Inc.*

538 FOREST STREET, KEARNY, N.J.

Look to Oakite WHEN FINE PLATING CALLS FOR PRECISE SURFACE-PREPARATION

Why risk rejects, slowdowns, metal loss by trying to obtain good electroplates on inadequately cleaned work? It's the long way around—and costly—particularly when specialized Oakite pre-plating cleaners are available to serve you!

Time-tested Oakite materials provide the precise degree of chemical cleanliness required for specific plated finishes. They remove oil, grease, dirt, fabricating compounds quickly, thoroughly. Emulsify rapidly and rinse freely. Assure tenacious, uniform adhesion of a great variety of finishes. Give trouble-free, low-cost service. Perform dependably in conveyorized operations.

How to Speed and Save!

Whatever the metal, the electroplate, the production process . . . continue the good habit of consulting your Oakite Technical Service Representative on your pre-plating problems. His services are free for the asking, without obligation. Or write on letterhead to us for full free data on particular procedures.

OAKITE PRODUCTS, INC., 40 Thames St., NEW YORK 6, N. Y.

Technical Service Representatives Located in All Principal Cities of the United States and Canada

OAKITE *Specialized* **CLEANING**

MATERIALS · METHODS · SERVICE · FOR EVERY CLEANING REQUIREMENT

FREDERIC B. STEVENS INCORPORATED
EVERYTHING FOR PLATING AND POLISHING
DETROIT · 26 · MICHIGAN
What's a trademark worth . . .
EVER GIVE IT A THOUGHT?
A trademark can mean a whole lot! For example—when you see the STEVENS ELEPHANT and the slogan "EVERYTHING FOR PLATING AND POLISHING" associated with
POLISHING, BUFFING, COLORING, and DEBURRING COMPOSITIONS.
you can rest assured that it carries a two-fold guarantee of extra quality . . . laboratory control of raw materials —combined in proper percentages and tested under actual working conditions to assure the best obtainable results in your finishing operations.
There is a Stevens Composition especially developed for use on all types of mechanical or hand buffing operations —"precision" materials, exactly uniform in formula, texture and quality. For better all-around results, use a composition bearing the Stevens trademark.
GREASELESS COMPOSITIONS
(Glue Base) for
DEBURRING
POLISHING
BUTLER, SATIN and BRUSH FINISHING
BUFFING COMPOSITIONS
(Steric Acid Base) for
DEBURRING
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BUFFING
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BUFFING COMPOSITIONS • METAL POLISHERS AND ELECTROPLATERS SUPPLIES-EQUIPMENT

THE MONTHLY

Review

VOLUME 33 • SEPTEMBER 1946 • NUMBER 9

Published Monthly at
5800 N. MERVINE STREET
PHILADELPHIA 41, PA.
AMERICAN ELECTROPLATERS' SOCIETY
EXECUTIVE OFFICE
P. O. Box 168
JENKINTOWN, PA.
Phone: Ogontz 4663

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Subscription $3.00 a year
50 cents per Copy

Entered as second class matter September 14, 1945, at the post office at Paterson, N. J., under Act of August 24, 1912. Application pending transfer to Philadelphia, Pa., Post Office.

Du Pont Precious Metal Cyanides give outstanding results in precious metal decoration.

7. Gold cyanides permit a wide range of gold colors—from yellow to antique green.

Du Pont Precious Metal Cyanides give outstanding results in precious metal decoration. Du Pont Potassium Cyanide is widely used with these materials. Readily made up into plating solutions, these salts offer important advantages:

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2. **Readily dissolved in cyanide solutions.**
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4. **Give effective solutions that are simple to control and maintain.**
5. **Solutions yield uniformly satisfactory results at greatest speed.**
6. **Produce a soft finish—easily buffed or shaded.**
7. **Gold cyanides permit a wide range of gold colors—from yellow to antique green.**

Du Pont Technical Service Men will work with you in selecting cyanides, preparing plating solutions and in operating your processes for maximum speed and economy. Clip the coupon below for your copy of our illustrated Operating Manual, "Electrodeposition of Gold and Silver." E. I. du Pont de Nemours & Co. Inc., Electrochemicals Department, Wilmington 98, Delaware.

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for ELECTROPLATING

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BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

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Electrochemicals Department
Wilmington 98, Delaware

Please send my copy of your Operating Manual, "Electrodeposition of Gold and Silver."

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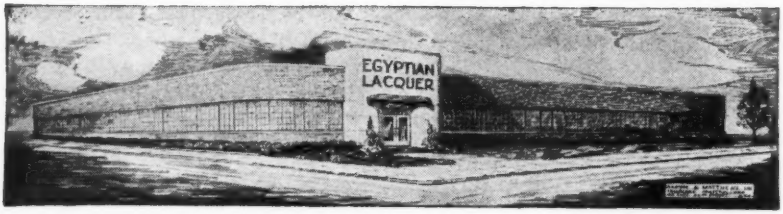


New Egyptian Building at South Kearney, N. J.

Sales, advertising and accounting departments of Egyptian Lacquer Manufacturing Company have moved into a modern home recently erected on the company's factory site at South Kearney, N. J.

The new structure, in proximity to Egyptian's laboratory and manufacturing facilities, increases our ability to serve you. Please note the new address and mark your records accordingly.

Executive headquarters remain at Rockefeller Center, New York City.

THE EGYPTIAN LACQUER MANUFACTURING COMPANY
JACOBUS AVENUE, SOUTH KEARNEY, N. J.
MAIL ADDRESS—P. O. Box 444, NEWARK, N. J.

EGYPTIAN FINISHES

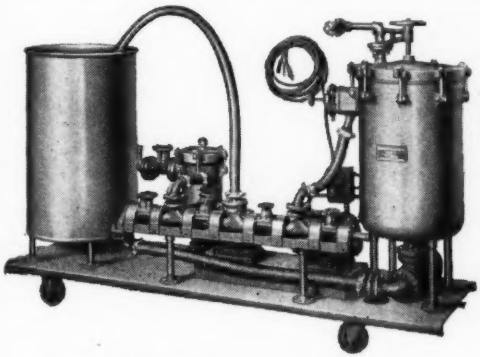
EGYPTIAN
SPECIALIZED PRODUCTION FINISHES

FOR GREATER *Efficiency* AND *Economy*

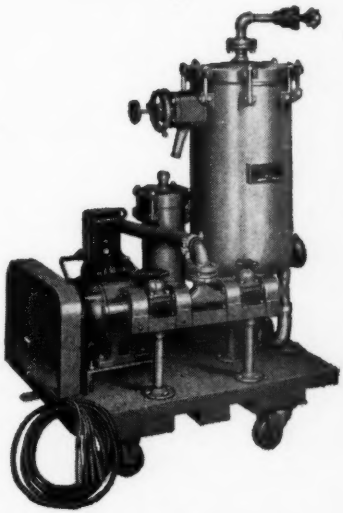
INSTALL MODERN INDUSTRIAL FILTERS IN YOUR PLATING PLANT

You can keep your plating plant operating at top efficiency only if you have adequate filtration. Industrial filter systems are designed and built to provide continuous high speed filtration and circulation.

Industrial Filters equipped with the AIRWASH cleaning feature have been in continuous use for months without opening the filters or removing the plates. Air agitation quickly dislodges the accumulated sludge and leaves the filter clean and ready for a new filter cycle. Many hours of production time are saved thus lowering your operating costs.



No. 1—Filter shown is equipped with slurry tank with double suction and discharge control providing an ideal continuous filtration system.



No. 2—A typical portable filter as constructed for bright nickel, acid copper and other acid type bath. Used for either intermittent or continuous filtration.

Other Products

Salt Fog Corrosion Test Equipment

Centrifugal Pumps of Duriron, Worthite, Stainless Steel, Hard Lead, Bronze and Iron.

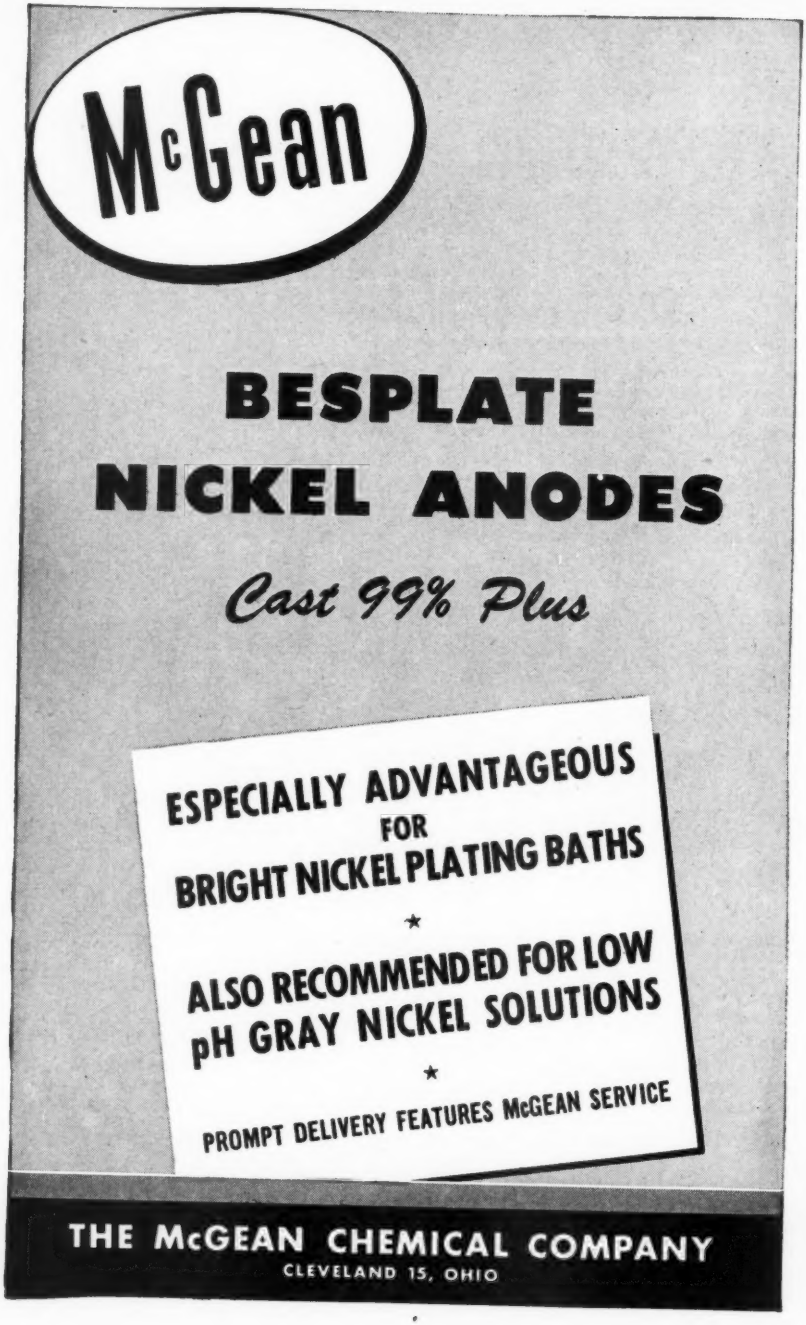
In Stock

Filterbestos
Activated Clay
Activated Carbon
Filter Powder
in all grades

Prompt shipment

INDUSTRIAL FILTER & PUMP MFG. CO.

1621-39 WEST CARROLL AVENUE **CHICAGO 12, ILLINOIS**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BESPLATE
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Cast 99% Plus
ESPECIALLY ADVANTAGEOUS
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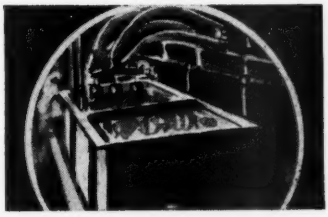
BRIGHT NICKEL PLATING BATHS
★
ALSO RECOMMENDED FOR LOW
pH GRAY NICKEL SOLUTIONS
★
PROMPT DELIVERY FEATURES McGEAN SERVICE
THE McGEAN CHEMICAL COMPANY
CLEVELAND 15, OHIO

LO·HI pH

BETTER . . . FASTER LOWER COST CLEANING

Due to a recent improvement in product . . . in method of charging . . . in control . . . our "Lo-Hi" pH Cleaning Process is better today than ever . . . Whether manually operated or fully automatic, if your plating procedure is orthodox, "Lo-Hi" will do your job better—faster and at lower cost regardless of type of steel or soil . . . Let us prove it at your convenience and if you are not convinced—it will be at our expense.



LO·HI

NORTHWEST CHEMICAL CO.

9310 ROSELAWN DETROIT 4, MICH

pioneers in pH cleaning control—serving you since '32

PARTLY CLEAN MEANS TROUBLE

(Advice that applies to metal plating, too)

Keeping electroplating solutions clean, like keeping the family bathtub bright and sparkling, is a job that calls for thoroughness. Putting well-cleaned work into an impure plating bath just doesn't make sense. Not only that, it's sure to result in trouble.

What kind of trouble? Pitting, spotting, poor adhesion. That's where Darco S-51 comes into the picture. It's an activated carbon that keeps your plating bath continuously clean—removes grease, oil, soap, colloids and other decomposition products.

A fine black carbon employed in conjunction with a filter, Darco S-51 is used in many types of electroplating, including bright nickel plating, cyanide zinc, cadmium, copper, iron, silver and gold.

The cost? Only a few cents a week. Get a supply of Darco S-51 from your dealer—or, if you have a special plating problem, call in the Darco representative.

●

(This trademark identifies the genuine. Accept no packages without it.)

DARCO

DARCO—REG. U. S. PAT. OFF.

DARCO CORPORATION

60 E. 42nd Street, New York 17, N. Y.

Is Your Plating Bath as Clean as the Water Used in Your Final Rinse?

FOR *BIG-TIME* RESULTS

FROM SMALL PLATING TANKS . . .

Here's a "baby" in the G-E line of copper-oxide plating rectifiers that does a man's work on silver, nickel, chromium, or what-have-you. Completely self-contained, with adjustment from zero to full voltage by means of variable-voltage transformer. No moving parts. Height 25 in., weight 180 lb. D-c output is 50 amp at 5 volts, from 115-volt a-c line. Details from Section A13-9106, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

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NANKERVIS

Announces

• • •

Improved Compound Applicator. Total weight 20 pounds, completely installed at any angle on any type automatic, either as single unit or in stages.

14 strokes per minute.

10 adjustments of feed. Motor Driven.

110 volt, 220 volt or 440 volt.

Nankervis applicators are now in operation in many plants doing everything from simple to complex multiple buffing operations.

•

Write today for detailed bulletin.

GEORGE L. NANKERVIS COMPANY

5442 Second Blvd., Detroit 2, Michigan

COMPLETE METAL FINISHING EQUIPMENT

for all plating solutions

continuous or intermittent operation

SPARKLER HORIZONTAL PLATE FILTERS

SPECIFIC MATERIALS *for* *SPECIFIC* SOLUTIONS

SPARKLER HORIZONTAL PLATE FILTERS

5,000 G.P.H. unit rubber-lined for bright nickel. (Plates also removable individually by hand.)

- Large area for continuous operation.
- Compact—unit shown occupies 44"x66".
- Uniform, high quality filtration.
- Easy cleaning.
- Leakproof, pressure-tight.
- Use either powder or pads.
- Low operating cost.

details on request

SPARKLER MFG. CO.

274 Lake Street Mundelein, Illinois

DURANITE

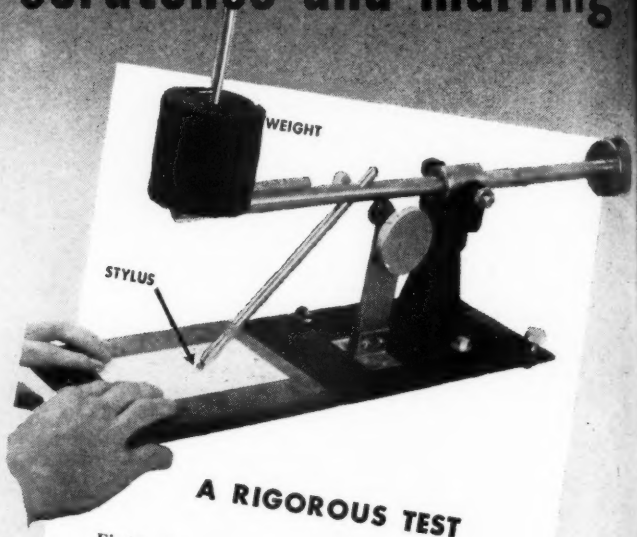
The Production Finish

withstands scratches and marring

DURANITES pass rigid scratch and mar resistance laboratory tests — tests that make normal consumer wear and tear fade into insignificance.

DURANITE is a heat-reactive, plastic-base finish that's really tough! It has excellent adhesion; resists abrasion, humidity, checking, fats and oils, soap and water. DURANITE is fast-curing, comes in white, clear and a variety of *lasting* colors.

The test illustrated is only one of many used by Zapon to make sure that DURANITE meets your requirements. Ask the Zapon Representative about DURANITE.



A RIGOROUS TEST

Finished panel is pushed beneath the rounded stylus under pressure of weights which are increased until the finish is stripped off or meets desired standards of mar resistance.

Scratch Resistance is measured by using pointed needle for stylus and increasing the weight until the finish is ruptured. In this way comparison and evaluation of finishes can be accurately estimated.

One of a series of advertisements showing how Zapon tests assure better finishes.

TEST NO. 4

ZAPON DIVISION
ATLAS POWDER COMPANY

Complete Manufacturing . . . Research . . . Sales

Stamford, Conn. North Chicago, Ill.

SPECIALIZED PRODUCTION FINISHES . . . *Doing Tomorrow's Job Today!*

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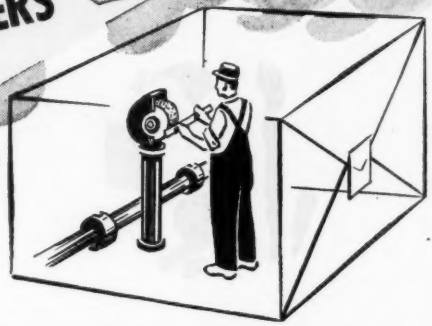
for POLISHERS



AT LAST! You Can Keep Production in High Gear Regardless of the Weather with GRIPMASTER

PAT. PEND.

POLISHING WHEEL CEMENT

Extensive tests by users and in our own laboratories prove:

When Gripmaster is used 40 minutes at 150° F. it dries the wheel head completely . . . makes it *impervious* to moisture! Gripmaster retains its adhesive properties even in the most humid room. Discover this important new benefit for yourself. Send for generous free sample today!

GRIPMASTER DIVISION
Nelson Chemical Corporation
formerly Michigan Bleach & Chemical Co.)
Detroit 27, Michigan

IN CANADA:
Nelson Chemical Co.
Windsor, Ontario

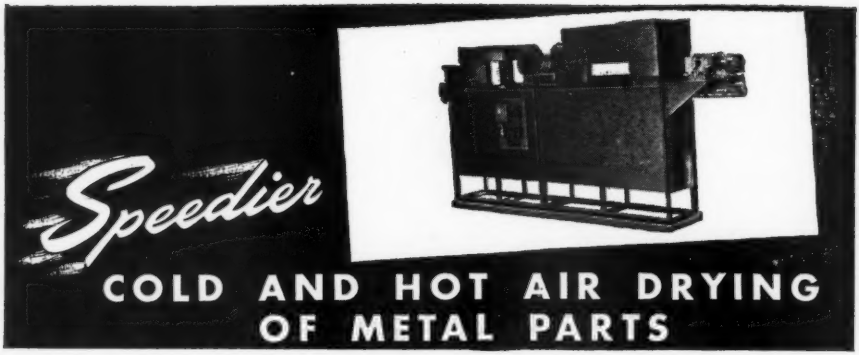
Please send us a generous free sample of Gripmaster, fortified against humidity.

COMPANY_____

ATTENTION_____

ADDRESS_____

CITY_____ STATE_____



Faster drying of metal parts on racks is accomplished with the use of the new OPTIMUS Continuous Type Drying Machine. Ideal for handling loaded racks continuously after plating, or after any water solution dip. Drying time runs 4 to 6 minutes.

This new OPTIMUS Dryer is used largely as a cold air and hot air dryer. Cold air system includes a blower and a series of nozzles. Hot air system includes an air heater, re-circulating blower, a damper to adjust the mixture of atmospheric and re-circulating air, and necessary nozzles.

It can be used as a single stage dryer, or it can handle a number of successive operations, alkaline, acid, or neutral. Enclosed design of machine permits efficient ventilation through exhaust blower connection when desired. Can be heated by steam, gas or electricity.

An OPTIMUS Plan for the mechanized handling of your metal parts through washing, rinsing and drying, can help you save labor, reduce rejects and increase your production.

SEND FOR

Your copy of new bulletin "Cleaning Metal Parts before and after finishing"

DEPENDABLE OPTIMUS DETERGENTS
cleaning equipment for every metal operation.

OPTIMUS EQUIPMENT COMPANY

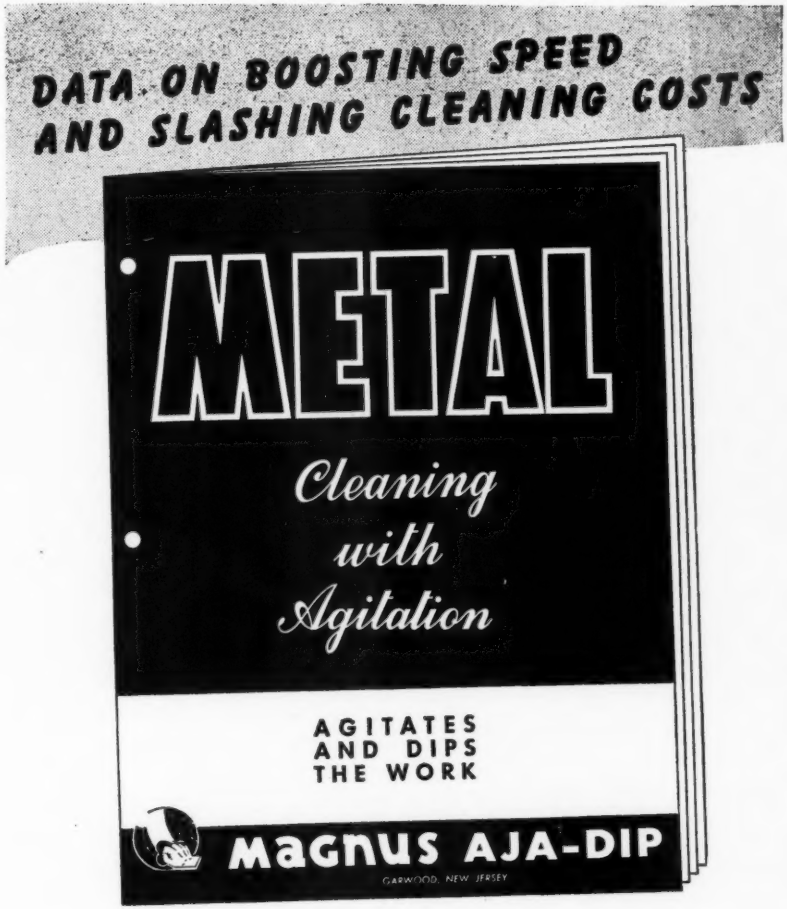
ENGINEERS AND MANUFACTURERS

131 CHURCH STREET, MATAWAN, N. J.

STANDARD AND SPECIAL TYPES OF EQUIPMENT FROM THE SMALLEST TO THE LARGEST SIZES FOR A WIDE VARIETY OF OPERATIONS.

OPTIMUS EQUIPMENT

FOR WASHING · RINSING · PICKLING AND DRYING OF METAL PARTS



Just off the press, this bulletin covers the basic principles, design and broad fields of use of the Magnus Aja-Dip Cleaning Machine which has demonstrated its ability to speed up the cleaning job by surprisingly large margins on all types of metal cleaning operations. The bulletin contains complete data on sizes and capacities, selection of heating methods and the type of Magnus Cleaner best suited to specific cleaning problems.

Tell Us How Many Copies You Can Use

A research man at Wyandotte Chemicals Corporation uses the Comparoscope to evaluate and compare the finishes on metal surfaces. By means of this carefully designed optical instrument, Wyandotte was able to make the burnishing-compound improvements that resulted in Wyandotte Burnishing Compound 315.

AN *IMPROVED* BURNISHING COMPOUND

This new development in burnishing compounds is free of annoying and hazardous cyanide. Yet it surpasses the old-fashioned cyanide treatment in removing tarnish from copper base alloys, brass, bronze and copper. It gives the finest and brightest of finishes.

Wyandotte Burnishing Compound 315 rinses freely from the work and burnishing balls. It leaves no objectionable soap films to dull the work — no hard-water scum to call for frequent cleaning.

Your Wyandotte Representative will be glad to show you what lustrous surfaces you get by using Wyandotte Burnishing Compound 315. Why not give him a call today?

Wyandotte

REG. U. S. PAT. OFF.

WYANDOTTE CHEMICALS CORPORATION

J. B. FORD DIVISION • WYANDOTTE, MICHIGAN

SERVICE REPRESENTATIVES IN 88 CITIES

CHROMIUM CHEMICALS

FOR THE ELECTROPLATER

- BICHROMATE OF POTASH
- BICHROMATE OF SODA
- CHROMIC ACID

MUTUAL CHEMICAL COMPANY OF AMERICA

270 MADISON AVENUE NEW YORK 16, N.Y.

THREE Products

ONE Source

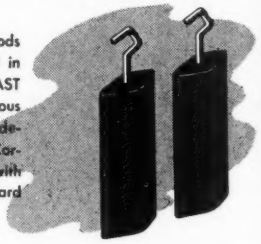
APOTHECARIES HALL COMPANY
WATERBURY CONNECTICUT
1849
97TH Year

One Standard of Quality

Apothecaries Hall Trade Mark your assurance of unvarying quality. For 97 years AHCO products have been preferred by the metal finishing industry because of dependable performance.

NUCAST 99+% NICKEL ANODES

Advanced production methods and rigid laboratory control in the manufacture of NUCAST Anodes produces a homogenous grain structure resulting in dependable plating efficiency. Corrosion is fast and even, with anode surfaces remaining hard and firm until exhausted.

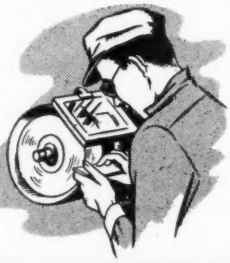


AHCOLOID METAL CLEANERS

For every industrial cleaning operation there is a specialized AHCOLOID Cleaner, with a method of application thoroughly proved by use in hundreds of plants. AHCOLOID Cleaning Compounds save countless production hours . . . do the job thoroughly . . . quickly.

AHCO BUFFING COMPOSITIONS

Standard grades of AHCO Buffing Compositions have been developed to meet practically every plant condition. Special compounds are available for cutting and coloring sterling silver, chromium, aluminum, hard rubber, and plastics.



APOTHECARIES HALL COMPANY

Box C WATERBURY 88 CONN.

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VARIABLE SPEED
LATHES

Reliance Variable Speed Lathes Cut Costs

There is a RELIANCE LATHE for every need.

Let us quote on your requirements.

Chas. F. L'Hommedieu & Sons Co.

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CLEVELAND

Start with a Good Finish!

For BUFFING

PURICO WONDERBAR . . . a Tripoli bar composition . . . pre-saponified . . . for speedier polishing and buffing. Easily rinsed from intricate patterns . . . eliminates old-fashioned manual scrubbing or washing.

For LACQUER STRIPPING

PURICO LACQUER STRIPPER . . . removes lacquer from steel and brass . . . faster acting . . . non-injurious to base metal.

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PURICO PUR-BUR . . . a fast, efficient compound for the deburring of aluminum . . . self-lubricating . . . eliminates burning and blistering of metal.

For DETINNING

PURICO BD ANODIC CLEANER . . . an effective reverse-current compound . . . designed especially for perfect detinning before plating . . . provides a superior finish.

YOU DEMAND

quality metal cleaning and finishing to maintain your reputation for quality . . . to increase production . . . to lower costs.

WE REFUSE

to lower our quality standards for PURICO Compounds . . . the best on the market for metal, cleaning and finishing compounds.

THE Puritan
MANUFACTURING COMPANY
WATERBURY, CONNECTICUT

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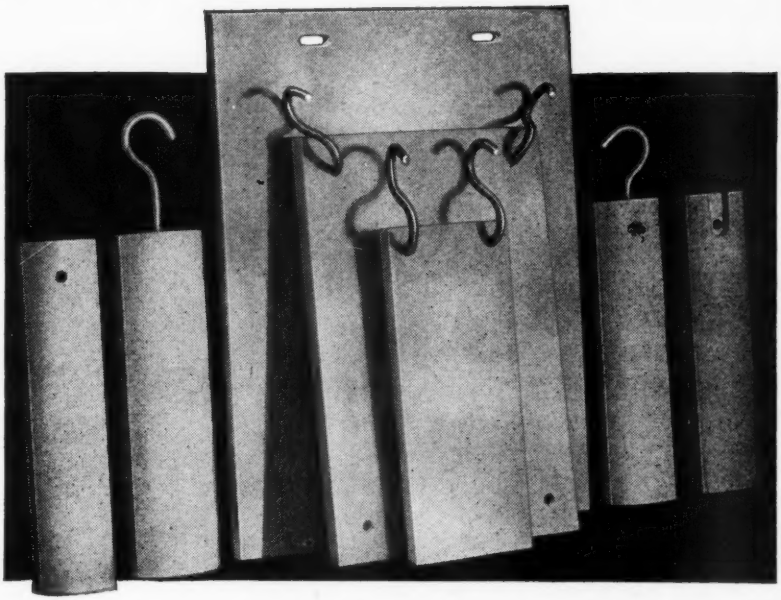

Enjoy all these advantages with *Anaconda Copper Anodes*

Anaconda Copper Anodes—whether Sheet, Oval, or Electro-deposited—contain less than 0.01 percent of total metallic impurities. This unexcelled high degree of purity pays you with the following advantages:

1 Copper goes into solution faster and more uniformly.
2 The highest quality deposit is produced in the shortest possible time.
3 Slime is reduced to an absolute minimum.
4 Spotting and discoloration of the deposit are eliminated.
5 Scrap losses are exceptionally low.

American Brass produces a complete line of Copper, Brass, and Bronze Anodes . . . rolled Sheet or Oval . . . cut to your own specifications or standard sizes . . . drilled or undrilled . . . with or without hooks—also Electro-deposited Anodes. For present or future reference, write for Publication C-5.

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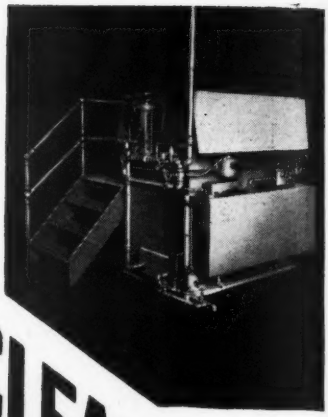

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COPPER PLATING from FLUOBORATE SOLUTIONS

By

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ABSTRACT

The results of an extensive investigation of the copper fluoborate plating electrolyte and its operating characteristics are presented in this article. The data include preferred bath compositions, the effect of bath constituents and additions on limiting cathode current densities and resistivity at several temperatures, current efficiencies, and anode performance, as well as hardness and tensile data on heavy copper deposits. The comparison of the fluoborate with the sulfate type of bath shows in a striking manner the high speed plating characteristics of the former type, which offers great promise in applications requiring heavy copper deposits. Rapid plating of moderate thicknesses of copper as an undercoat for nickel and chromium is also an attractive possibility.

INTRODUCTION

In recent years much emphasis has been placed on the application of deposits of greater thickness than those used formerly. As the specified thickness of the deposit is increased, the greater is the requirement for faster plating rates, because tank and equipment tie-up becomes a factor of prime importance. Fluoborate solutions have been found to allow use of exceptionally high plating rates. The availability in commercial quantities of copper fluoborate of high purity warranted investigation of copper fluoborate solutions to determine their plating characteristics, and development of baths for commercial application. The investigations disclosed that copper fluoborate, like the other metal fluoborates previously investigated, allowed exceptional plating speeds to be employed.

It was found that copper fluoborate possesses the following advantages as a plating solution:

1. It permits the use of current densities higher than those in any other copper bath.
2. The deposits are smooth and of excellent appearance.
3. Deposits obtained under certain specified conditions are soft and easily buffed to a high lustre.
4. Deposits produced under other specified conditions are hard and of high strength.
5. Anode and cathode efficiencies are approximately 100%.
6. The anode density is not critical.
7. Due to the high solubility of copper fluoborate, high concentration baths may be used without salt crystallizing on tanks and equipment.
8. Preparation of the bath from a fluoborate concentrate is simple, requiring only dilution with water and adjustment of *p*H with copper carbonate or fluoboric acid.
9. The bath is stable.
10. The bath is easy to control, requiring only *p*H and hydrometer determinations.

Copper fluoborate of high purity for plating baths is now available. Since the copper in the solution is in the form of the bivalent ion, plating rates can be ascertained from any table for copper plating from bivalent solutions. Being of the acid type, the solution is capable of depositing copper by immersion on the usual ferrous materials.

Hence a strike of cyanide copper must be applied on these materials before the application of copper from the fluoborate solution.

TABLE I
Standard Plating Solutions

	Regular	High concentration
Copper fluoborate, $Cu(BF_4)_2$, g/l	224	448
oz/gal	30	60
Copper, Cu, g/l	60	120
oz/gal	8	16
Gravity at 80° F, °Bé.	21–22	37.5–39
*p*H, colorimetric	1.2–1.7	≷ 0.6
Temperature, °F	80–170	80–170

BATH COMPOSITIONS

For regular tank plating the solutions in Table I have found wide application.

Other bath compositions above and below those given are workable. They should be chosen to give the desired results under the most economical and practical conditions. This usually leads to the selection of the lowest metal concentration with which the bath can be operated successfully at a practical current density, temperature and degree of agitation to give desired deposit characteristics.

EVALUATION PROCEDURE

Limiting current densities were used as a basis for the determination of the optimum copper concentration, bath composition and operating variables. In order to establish the limiting current density, the solution to be studied was placed in a glass cell 5.5 cm wide, 10 cm long and 7 cm deep with an anode of electrolytic copper in one end. Steel panels, approximately the size of the end of the cell, were cleaned thoroughly, given a flash of copper from a Rochelle cyanide copper bath, and placed against the end of the cell opposite the anode. They were then plated at various current densities for a time period calculated to give a thickness of one mil (0.001 inch). The limiting current density was taken as the current density value at which the first burning occured at the outer edges of a panel.

All *p*H values were determined simply with colorimetric *p*H papers which are sufficiently accurate for the control of the copper fluoborate solutions.

Resistivity values were determined by means of an Industrial Instrument Conductivity Bridge.

TABLE II

Effect of pH and Free Fluoboric Acid on Limiting Current Density and Resistivity

Bath Composition—60 g/l copper metal
16.2 g/l boric acid

Fluoboric Acid g/l	*p*H Colorimetric	Limiting current density,* asf		Resistivity ohm/cm³	
		80° F	120° F	80° F	120° F
0	1.4	150	225	8.4	—
2†	1.2	150	250	8.4	5.9
4	1.2	150	225	8.2	—
8	1.1	150	200	8.0	—
16.2	1.1	125	200	7.9	—
32	0.4	100	175	6.5	—
44	0.3	100	200	5.8	—
60	0.3	75	175	5.1	—
64	0.3	100	150	5.0	—
92	0.2	100	150	4.2	—
156	0.1	75	75	3.2	—

*Based on 1 mil thick deposits, no agitation

†Optimum value

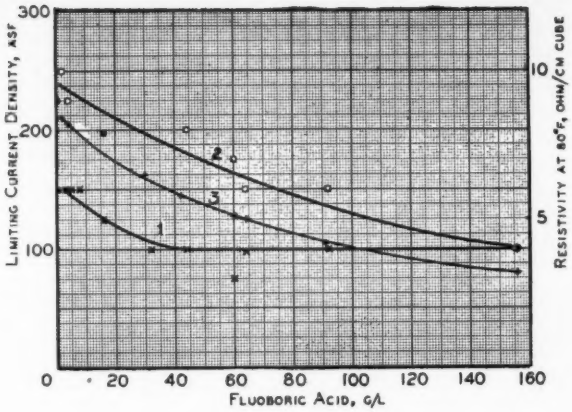

Fig. 1. Effect of fluoboric acid concentration in copper fluoborate baths containing 60 g/l copper and 16 g/l boric acid on the limiting current density at 80° F (curve 1) and 120° F (curve 2) and on resistivity at 80° F (curve 3)

RESULTS

Effect of Fluoboric Acid

In order to determine the effect of the fluoboric acid concentration on the operating characteristics of the bath, a concentrate of copper fluoborate was diluted to the required copper metal concentration. The concentration of fluoboric acid was calculated from the chemical analysis. Calculated amounts of copper carbonate or fluoboric acid were added to adjust the concentration of the acid to the values given in Table II.

The data in this table show that an increase in the fluoboric acid concentration of up to 8 g/l has little effect on the limiting current density. Higher acid concentrations lower the limiting current density. An increasing acid content of the bath increases

TABLE III

Effect of Boric Acid Concentration on Limiting Current Density and Resistivity

Copper content of baths—60 g/l

Fluoboric Acid g/l	Boric Acid g/l	*p*H Colorimetric	Limiting current density,* asf		Resistivity ohm/cm³ 80° F
			80° F	120° F	
2	2	1.3	150	225	8.1
2	4	1.3	175	225	8.2
2	8	1.3	150	225	8.3
2	16	1.2	150	250	8.4
2	32	1.2	150	250	8.5
32	16	0.4	125	200	6.1
32	24	0.4	100	175	6.2
32	48	0.4	100	150	6.5

*Based on 1 mil thick deposits, no agitation

the conductivity of the solution. In those installations where high limiting current density is not a prime factor, the free acid content can be raised to take advantage of the lower solutions resistivity or voltage requirement. These data also indicate the advantage of operation of the fluoborate copper bath at higher temperatures because of the decreased resistivity and the marked increase of the limiting current density. High operating temperatures can be used because the bath is extremely stable.

Effect of Boric Acid

The effect of the boric acid content of the solutions on the operating characteristics was determined in a bath containing 60 g/l of copper and 2 and 32 g/l of fluoboric acid. As shown in Table III, the boric acid concentration does not influence the limiting current density. An increase in boric acid content increases the solution resistivity slightly

Because of the small effect of the boric acid in the copper fluoborate bath, 15 g/l (2 oz/gal) is sufficient to insure stability of the bath. This amount is present in the fluoborate concentrate.

Effect of Copper Concentration

To determine the effect of the copper metal content of the fluoborate bath, tests were run with copper concentrations varying from 30 to 180 g/l, the fluoboric acid and boric acid concentrations being held substantially constant, as shown in Table IV, and Fig. 2.

The limiting current density is greatly increased by raising the copper concentration of the bath. With 30 g/l (4 oz/gal) copper, the bath gives satisfactory deposits, but the limiting current density is low, *i. e.*, 75 amp/sq.ft. at 120° F. An increase in the copper concentration to 60 g/l (8 oz/gal) increases the limiting current density three fold. The 120 and 180 g/l copper baths have

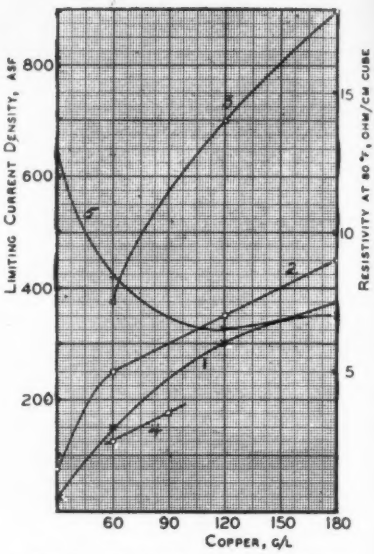

Fig. 2. Effect of copper concentration in copper fluoborate baths containing 2–4 g/l fluoboric acid and 16 g/l boric acid on limiting current density at 80° F (curve 1), 120° F (curve 2) and 170° F (curve 3) and on resistivity at 80° F (curve 5). Curve 4 represents the limiting current density for a copper sulfate bath at 120° F

TABLE IV
Effect of Metal Concentration and Temperature on the Limiting Current Density and Resistivity

Copper g/l	Boric Acid g/l	Fluoboric Acid g/l	*p*H Colorimetric	Limiting Current density,* asf			Resistivity ohm/cm³	
				80° F	120° F	170° F	80° F	120° F
30	16	2	1.6	25	75	—	12.8	—
60	16	2	1.2	150	250	375	8.4	5.9
120	16	2	0.6	300	350	—	6.6	—
120	16	8	0.6	300	350	—	6.6	4.7
120	16	32	0.4	300	375	700	6.3	—
180	16	4	0.4	350	450	—	7.5	—
180	16	46	0.3	350	450	900	7.2	—

*Based on 1 mil thick deposits, no agitation

limiting current densities of about 350 and 450 amp/sq.ft., representing five and six fold increases over the 30 g/l bath respectively. As shown by the data, the limiting current density values are still higher at higher temperatures.

An increase in the metal content of the fluoborate bath from 30 through 60 to 120 g/l copper decreases its resistivity while a further increase in metal content to 180 g/l results in an increase in resistivity. Increasing free fluoboric acid content also decreases the resistivity, but it lowers the limiting current density in the low copper bath.

Limiting current densities were determined at bath temperatures of 80, 120 and 170° F. The data indicate the advantage of high bath temperatures as a means of obtaining high limiting current density. High bath temperaures also give low resistivity of the solution and low tank voltage.

Comparison with Copper Sulfate Baths

Since it is apparent that copper fluoborate plating baths, because of their high permissible plating rates, are particularly well adapted to the electrodeposition of heavy deposits where copper sulfate solutions are now used extensively, limiting current densities in copper sulfate baths have been included for comparison. The procedure used was the same as that for limiting current densities in fluoborate solutions.

From the data summarized in Table V, it can be readily seen that copper fluoborate baths have much higher limiting current densities than acid sulfate baths of the same metal concentration. A second marked advantage is apparent. Because of the limit of solubility of copper sulfate in solutions acidified with sulfuric acid, sulfate copper baths are usually operated at approximately 60 g/l copper metal (240 g/l $CuSO_4 . 5H_2O$). More concentrated baths can be utilized at higher bath temperatures but the limit is about 90 g/l copper(360 g/l $CuSO_4 . 5H_2O$). The use of this high concentration bath is troublesome because the copper sulfate will crystallize out if the solution is allowed to cool and the tanks and equipment tend to become coated with copper salts. Copper fluoborate is so soluble that solutions with as much as 180 g/l copper can be used without salt formation around the equipment. With high concentration baths one may

TABLE V

Comparison of Limiting Current Density of Fluroborate and Sulfate Copper Baths

Type of bath	Copper g/l	Free Acid g/l	Limiting current density,* asf 120° F.	Resistivitity ohm/cm³ 120° F.
Fluoborate.....	60	2–4	250	5.9
Sulfate.....	60	30	125	4.23
Sulfate.....	60	85	100	1.84
Fluoborate.....	90	2–4	300	—
Sulfate.....	90	30	175	4.17
Fluoborate.....	120	2–4	350	4.7
Sulfate.....	120	85	§	§
Sulfate.....	60†	30	100	—
Sulfate.....	60‡	30	125	—
Sulfate.....	90†	30	175	—
Sulfate.....	90‡	30	175	—

*Based on plates 1 mil thick, no agitation
†With 1.2 ml/l molasses
‡With 2.9 ml/l phenol sulfonic acid
§Above solubility limit

TABLE VI

Effect of Sodium Fluoborate Concentration on Limiting Current Density and Resistivity

Bath composition— 60 g/l copper
2 g/l fluoboric acid
16 g/l boric acid

Sodium Fluoborate g/l	pH Colorimetric	Limiting current density,* asf		Resistivity ohm/cm³ 80° F
		80° F	120° F	
2	1.3	150	250	8.3
4†	1.3	150	250	8.2
8†	1.3	150	250	8.0
16†	1.3	150	225	7.5
32	1.3	100	200	7.4
64	1.3	100	175	7.2

*Based on plate 1 mil thick, no agitation
†Appeared to add luster to the deposits

employ current densities far beyond those which heretofore have been possible in unagitated copper plating solutions.

Because it is almost impossible to duplicate conditions or intensity of agitation, the copper fluoborate solution was evaluated and compared with acid sulfate copper baths without external agitation. The values of limiting current density can be increased by the use of agitation. The stability of the solution permits the use of air agitation as well as mechanical agitation, such as moving cathode agitation, pumping, etc.

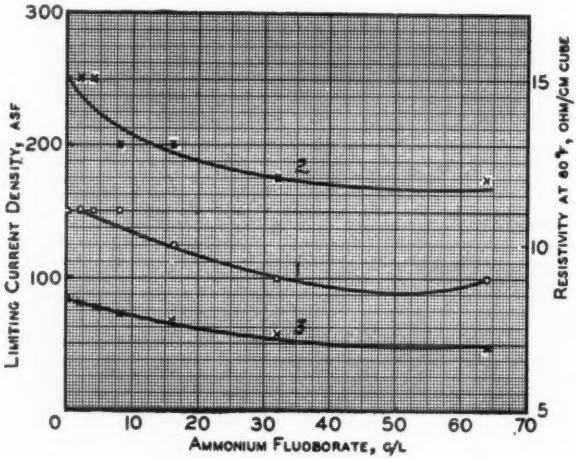

Fig. 3. Effect of ammonium fluoborate in copper fluoborate baths containing 60 g/l copper, 2 g/l fluoboric acid and 16 g/l boric acid on limiting current density at 80° F (curve 1) and 120° F (curve 2) and on resistivity at 80° F (curve 3). Sodium fluoborate has the same effect

TABLE VII

Effect of Ammonium Fluoborate Concentration on Limiting Current Density and Resistivity

Bath composition— 60 g/l copper
2 g/l fluoboric acid
16 g/l boric acid

Ammonium Fluoborate g/l	pH Colorimetric	Limiting current density,* asf		Resistivity ohm/cm³ 80° F
		80° F	120° F	
0	1.4	150	250	8.4
2	1.3	150	250	8.2
4	1.2	150	250	8.1
8	1.2	150	200	7.9
16	1.0	125	200	7.7
32	1.0	100	175	7.3
64	0.8	100	175	6.9

*Based on 1 mil thick deposit

Effect of Sodium Fluoborate

Various increments of sodium fluoborate were added to copper fluoborate to determine the effect on the operating characteristics of the bath.

Sodium fluoborate decreases the resistivity slightly. While small amounts have little effect on the limiting current density, large amounts lower it. The deposits plated in the presence of small amounts of sodium fluoborate appeared to have more luster than those produced without this salt. Because of the effect on limiting current density and the relatively small gain in

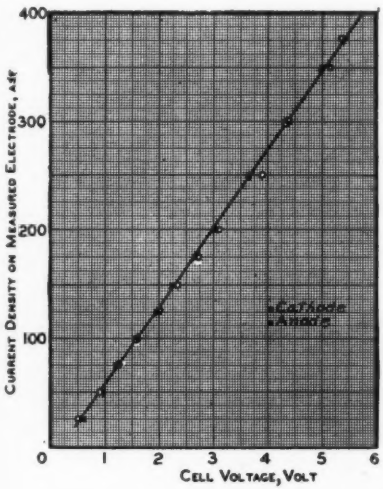

Fig. 4. Effect of current density on voltage across a cell with the area of the measured electrode 1/16 of the area of the other electrode in a copper fluoborate bath containing 60 g/l boric acid at room temperature and without agitation

TABLE VIII

Anode and Cathode Voltages

Measured Electrode—0.458 inch dia., 4 inch high; area 5.75 sq. in.
Other Electrode—7.25 inch dia., 4 inch high; area 91 sq. in.
Electrode Distance—3.4 inch
Solution:

Copper	60 g/l	pH 1.4
Boric Acid	16 g/l	Room temperature
Fluoboric Acid	2 g/l	No agitation

Current density on measured electrode	Bath voltage measured electrode as	
asf	Anode	Cathode
25	0.6	0.5
50	0.95	0.9
75	1.25	1.25
100	1.6	1.6
125	1.95	2.0
150	2.25	2.35
175	2.65	2.7
200	3.0	3.1
250	3.65	3.9
300	4.35	4.6
350	5.05	5.15
375	5.4	5.35

resistivity, it was not considered advisable to add sodium fluoborate to the plating bath.

Effect of Ammonium Fluoborate

The data summarized in Table VII and Figure 3 show that ammonium fluoborate added to the solution lowers its resistivity slightly and, in fairly large amounts, decreases the limiting current density. Because of the effect of ammonium fluoborate and sodium fluoborate on the limiting current density, only copper carbonate, rather than the alkali hydroxides, was used to raise the *p*H of all plating baths.

Polarization Data

The anode and cathode polarization characteristics of the copper fluoborate solution were studied by means of the following mechanism. The solution was placed in a cylindrical cell with a copper sheet electrode lining the inside of the cell and a small cylindrical copper rod centered within the cell. The ratio of the electrode areas was thus quite large, 16:1, in the set-up. Because of the large area of the one electrode and the small amounts of current used, cell voltage will reflect the polarization picture at the small electrode without undue influence of the reactions at the large electrode. Current was passed through the cell and the voltage was measured for various current densities with the small, measured electrode as anode and cathode, as shown in Table VIII and in Figure 4.

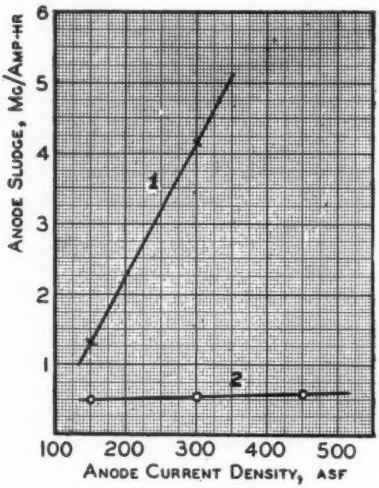

Fig. 5. Effect of current density on anode sludge formation in solutions containing 60 g/l copper (curve 1) and 120 g/l copper (curve 2), 30 g/l fluoboric acid and 16 g/l boric acid at 130° F

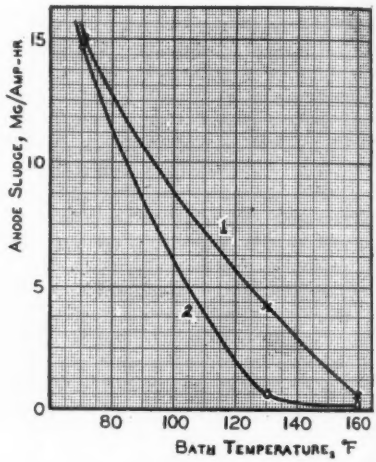

Fig. 6. Effect of bath temperature on anode sludge formation in copper fluoborate baths containing 60 g/l copper, 4 g/l fluoboric acid (curve 1) and 120 g/l copper, 30 g/l fluoboric acid (curve 2) and 16 g/l boric acid at 300 asf

TABLE IX

Anode and Cathode Efficiencies

Solution temperature—120° F.
Current density—100 asf

Copper g/l	Fluoboric Acid g/l	Boric Acid g/l	*p*H Colorimetric	Current efficiency %	
				Anode	Catode
60	2	16	1.4	99.5–101	98.8–100
120	8	16	0.6	100–101	99.5–100

The study of the anode behavior is of great interest because of the high anode current densities which can be employed without the excessive polarization or passivation of the copper anode which takes place at high current densities in acid sulfate solutions.

Current Efficiencies

The anode and cathode efficiencies were calculated from the anode weight loss and the cathode weight gain as compared to the theoretical weight change as determined from the amount of current and the length of time. The data presented in Table IX

TABLE X

Sludge Formation

Copper g/l	Fluoboric Acid g/l	Temp. °F	Agitation	Current Density asf	Time min.	Anode Type	Sludge mg/amp-hr*
			Effect of Copper and Fluoboric Acid Concentration				
60	4	130	None	300	30	Electrolytic	4.3
"	30	"	"	"	"	"	4.1
120	30	"	"	"	"	"	0.6
"	60	"	"	"	"	"	0.6
180	30	"	"	"	60	"	3.4
			Effect of Current Density and Agitation				
60	4	130	None	150	30	Electrolytic	1.3
"	"	"	"	300	"	"	4.3
"	"	"	Air	"	"	"	3.8
"	30	"	None	150	"	"	1.6
"	"	"	"	300	"	"	4.1
120	"	"	"	150	"	"	0.5
"	"	"	"	300	"	"	0.6
"	"	"	Air	300	"	"	0.6
"	"	"	None	450	"	"	0.6
"	"	"	Air	800	"	"	7.1
			Effect of Temperature				
60	4	70	None	300	30	Electrolytic	15.2
"	"	130	"	"	"	"	4.3
"	"	160	"	"	60	"	0.2
120	30	70	"	"	30	"	14.9
"	"	95	"	"	"	"	16.7
"	"	130	"	"	"	"	0.6
"	"	160	"	"	60	"	0.4
			Effect of Anode Type				
60	4	130	None	300	30	Electrolytic	4.3
"	"	"	"	"	"	Rolled Annealed	6.8
"	"	"	"	"	"	Cast†	2.1
120	30	"	"	"	"	Electrolytic	0.6
"	"	"	"	"	"	Rolled Annealed	0.7
"	"	"	"	"	"	Cast†	0.5
			Comparative Data for Copper Sulfate Solution				
60	37.5 (H_2SO_4)	130	None	150	60	Electrolytic	38.0
60	37.5 (H_2SO_4)	"	Air	"	"	"	13.3

*1.0 mg/amp·hr = 0.08% of copper

†Black film on anode

shows the current efficiencies to be about 100 per cent. Since there is no evolution of hydrogen or oxygen given off during plating, there is no spray and tank ventilation is simplified.

Anode Performance

Electrolytic or rolled annealed anodes were discovered to be most satisfactory in this bath, although cast anodes of high purity have been found to work well. In installations where the plating of very thick deposits has necessitated the use of anode bags, vinyon has been employed successfully.

Acid baths are usually characterized by the formation of a reddish brown sludge on the anode. Solution agitation, if excessive, may remove this film which may subsequently be carried to and deposited on the cathode, resulting in rough nodular deposits.

The results obtained in the study of anode sludge are summarized in Table X and in Figures 5 and 6. These data show that the amount of sludge formed at the anode in fluoborate solutions is quite small in comparison with that produced in sulfate solutions. It is reddish brown in color and is similar in appearance to that in sulfate copper baths. The solution containing 120 g/l copper forms less anode sludge than is formed in the 60 g/l or the 180 g/l copper baths. In the 60 g/l bath, increasing anode current density increases the amount of anode sludge, whereas in the 120 g/l bath, increased anode current density over the range

TABLE XI

Physical Properties of Deposits

Current density—300 asf

Copper g/l	Fluoboric Acid g/l	Temp. °F	Addition Agent g/l	Hardness Rockwell 15T
		Effect of Bath Composition on Hardness		
60	2–4	120	None	44–52
"	30	"	"	43–50
120	2–4	"	"	58–62
"	30	"	"	59–63
"	60	"	"	67–70
		Effect of Bath Composition and Temperature on Hardness		
120	30	120	None	59–63
"	"	95	"	68–74
"	60	120	"	67–70
"	"	95	"	58–60
		Effect of Addition Agent		
60	2–4	120	None	44–52
"	"	"	0.2 Triton 720	65–67
"	"	"	0.2 Triton 720 1.2ml/molasses	68–70
"	"	"	0.01 Thiourea	73–74
"	"	"	0.01 Thiourea 0.2 Triton 720	76–77
"	"	"	0.2 Triton 720 2 Decolyte	57–57.5
"	"	"	10 ppm glue	67–72
"	"	"	1.2 molasses	64–70

studied has little effect, the quantity of sludge being very small. Air agitation in the copper fluoborate bath has little effect on the amount of sludge formed, although the anodes do appear cleaner because vigorous air agitation will sweep the sludge from the anode into the solution. Increasing bath temperature decreases the amount of anode sludge. In those applications where the sludge must be kept at a minimum, high temperatures should be employed. Anode bags can also be used to maintain the solution free from sludge or anode particles.

Electrolytic, rolled annealed, and cast copper anodes were tested for their relative effect on anode sludge formation. The results obtained, summarized in the latter part of Table X, indicate that less sludge accumulated on the cast anodes than on the other types. However, cast anodes were characterized by the development of a black adherent film that required scrubbing for removal. The film is believed due to impurities in the anode. Because of this, electrolytic or rolled annealed anodes are recommended for use in the fluoborate bath, although cast anodes of exceptional purity have been used successfully.

The small amount of anode sludge formed in the copper fluoborate bath is not detrimental in the usual plating applications. The data are presented to indicate trends which may be useful in those particular applica-

TABLE XII

Physical Properties of Deposits

Thickness—20 mil
Current density—300 asf
Mechanical solution agitation

Copper g/l	Fluoboric Acid g/l	Temp. °F	Yield Point psi	Tensile Strength psi	Enlongation in 2 inch	Hardness Rockwell 15T
120	30	95	—	30,600	3.5	68–74
			—	22,500	2.5	
			28,000	34,500	3.5	
			Aver. 28,000	32,500	3.2	
120	30	120	19,850	30,100	14.0	59–63
			19,200	29,100	14.0	
			21,750	29,400	15.5	
			Aver. 20,230	29,500	14.5	
60	4	120	12,800	17,000	8.0	44–45
			13,200	17,200	7.5	
			12,700	15,700	6.5	
			Aver. 12,900	17,100	7.3	
60*	4	120	22,600	30,800	11.0	64–70
			23,600	28,700	—	
			Aver. 23,100	29,800	11.0	
60†	4	120	22,750	30,300	9.0	57–57.5
			(16,400)	(23,100)	(5.0)	
			20,200	30,300	12.0	
			Aver. 21,480	30,300	10 5	

*With 1.2 ml/l molasses
†With 2 g/l Dacolyte

tions where slight sludging is a factor that may contribute to rough deposits.

Character of Deposits

A series of tests was run to determine the effect of various solution and plating variables on the character of the deposits. The deposits were plated 20 mils in thickness at a cathode current density of 300 amp/sq. ft. in solutions vigorously agitated with mechanical stirrer. The fluoborate copper was applied to steel panels which had been given a copper cyanide strike followed by a sulfide treatment. This procedure was used in order that the structure of the copper deposits would be relatively free from influence of the base metal and so that the copper could easily be separated from the steel.

The results of the tests, summarized in Tables XI and XII, point to some interesting facts about copper deposited from fluoborate solutions. Copper applied in the 60 g/l bath is soft and quite ductile. The concentration of acid in the bath has little effect on the hardness. The 120 g/l copper bath gives much harder deposits with greater tensile strength and ductility. The fluoboric acid concentration of the bath has little effect on the hardness of the deposit until a large excess of free acid is added when it has a hardening effect. Lowering of the bath temperature of the 120 g/l bath containing 30 g/l fluoboric acid, causes the hardness and tensile strength of the deposits to increase. At a higher concentration of acid in this bath, there appears to be a reversal of this effect.

A number of addition agents were tested in the fluoborate bath. Those listed in Tables XI and XII increase the hardness and refine the grain size, smooth the deposits and decrease treeing on exposed edges. It is interesting to note that the use of the addition agents listed in Table XII is accompanied by an increase of the hardness and tensile strength of deposits from the 60 g/l bath to a point where they compare favorably with deposits from the 120 g/l bath. In addition, the elongation or ductility of the deposits is excellent.

The results presented in these tables are not intended to be absolute values but are merely indicative of what is to be expected. Preliminary data from further work just undertaken indicates that the substitution of air agitation for mechanical agitation will increase the hardness values given in the tables.

APPENDIX

Preparation of Bath

Copper fluoborate is available in the form of a concentrated deep blue solution, having the characteristics shown in Table XIII.

The concentrate (specific gravity of 1.54 at 68° F) weighs about 12.8 lbs per gallon and can be diluted directly with water.

TABLE XIII

Copper Solution Concentrate

Typical analysis	Wt.-%	g/l	oz/gal
Copper Fluoborate, $Cu(BF_4)_2$.....	45.0	693	92.9
Copper, Cu.....	12.1	186	24.9
Fluoboric Acid HBF_4.....	3.0	46	6.2
Boric Acid, H_3BO_3.....	3.0	46	6.2

To prepare a bath of any desired concentration, the required amount of concentration is measured, poured directly into the tank, and then diluted to volume with a good grade of water, low in chlorides. After dilution, the solution should be adjusted to the specifed operating *p*H. The solution *p*H should be raised with small increments of copper carbonate or lowered by adding small amounts of plating-grade fluoboric acid.

Bath Control

The control of the bath is very simple. The copper content can be estimated by determination of the specific gravity of the solution with a hydrometer. If desired, the copper content can be determined by chemical analysis. The acidity of the bath is controlled by checking the *p*H of the solution with colorimetric *p*H paper. As the acidity of the solution is not critical, this simple method of control has been found adequate.

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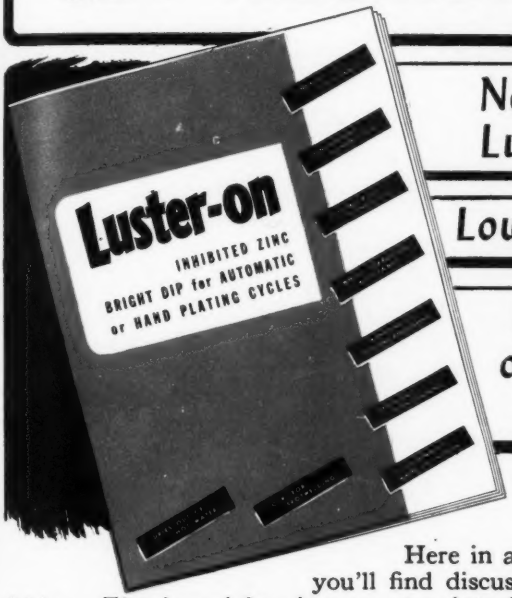

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Monthly Review, September

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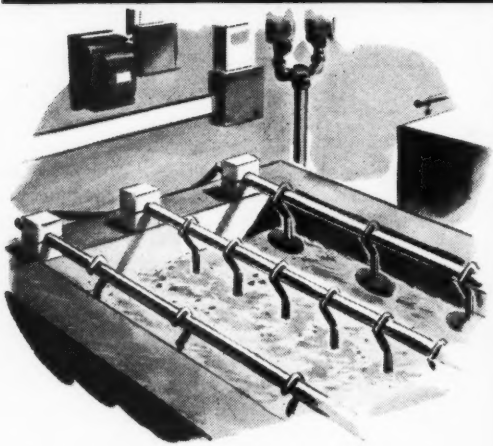

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SILVER PLATING BEARINGS

By F. C. MESLE *Superintendent, Bearing Division,*
Oneida Ltd.—Oneida, N. Y.

Fig. 1. The author (second from left) hands the one-millionth bearing produced at Oneida Ltd. to M. E. Robertson, General Manager. Other participants in the ceremony are from left to right: R. W. Landon, the author's assistant, M. E. Kinsley, Vice-President, and M. W. Keller, Works Manager. In the background are some units for inside plating of bearings

One of the many war projects of Oneida Ltd. was the silver plating of more than two and one-half million aircraft bearings (Fig. 1). The average weight of silver plate on a bearing was about 10 ounces. The full 3-shift capacity for plating was 35,000 bearings weekly. When plating to capacity, we deposited over 12 tons of silver per week. The fact that Oneida was only one of a half dozen concerns producing silver plated bearings will give some idea of the demand for silver-lead-indium bearings during the war.

Why Use Silver?

The silver-lead-indium bearings have proven their worth in longer life under high speed and high unit load than other bearings used in aircraft engines, such as those made of or lined with lead-base babbitt, tin-base babbitt, cadmium-silver alloys, copper-lead alloys and aluminum alloys.

The four vital factors that determine the quality of a bearing material are in order of their importance: fatigue resistance, corrosion resistance, score resistance and embedability. Silver-lead-indium is superior in respect to fatigue and corrosion resistance and fair in regard to score resistance but low as far as embedability is concerned (Fig. 2). Good filtration makes it possible to have clean oil in aircraft bearings and, therefore, embedability is not too important a factor.

The different bearing materials are rated in order of decreasing performance as follows: silver-lead-indium, silver-lead-grid, copper-lead grid, copper-lead alloy, aluminum alloys,

cadmium-silver alloys, lead-base babbitt, and tin-base babbitt.

At high speed and high unit load, silver bearings may have more than 30 times the life of babbitt bearings and 10 times the life of copper-lead bearings, the latter being conventional for aircraft and automobile engines prior to the introduction of silver. There are some manufacturing economics in the use of silver as compared with copper-lead so that the cost of the silver bearing is only about twice that of the copper-lead bearing. With from five to ten times the life and only twice the cost, it is not difficult to understand why silver should be employed in aircraft bearings.

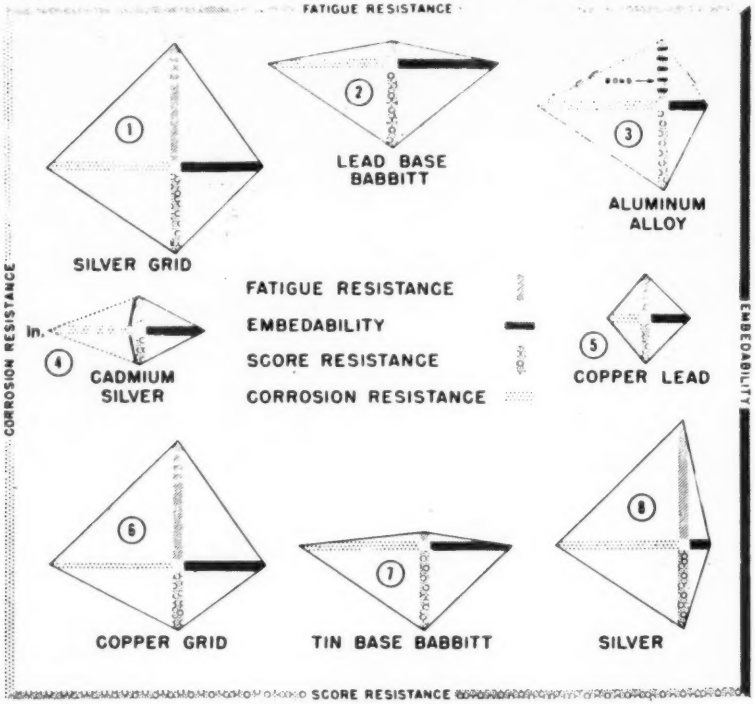

Fig. 2. Functional properties of bearing materials when securely bonded to steel or high strength bronze backing. Courtesy S. A. E. Journal (September, 1945)

Specifications

Specification AMS 4815A, issued by the Society of Automotive Engineers, calls for silver plating on a steel back made from low carbon steel. The deposit must contain not less than 99.75 per cent silver. After proper cleaning, a copper or nickel strike or flash may be used. The silver varies from 0.020 to 0.060 inch in thickness as may be required by the blueprint for a given bearing, and should be free from excessive nodules, inclusions and visible porosity. Fine grained in structure, it should have a Rockwell 15W hardness of 60-85 or its equivalent.

After plating, the bearings are heated to between 900 and 1,000° F for one hour when a nickel strike is used, and to a temperature of about half this value when a copper strike is employed. (See AMS 2412.)

The silver must be well bonded to the steel back, i.e., it shall not be separable in any adhesion test, including the hammer and chisel test. X-ray and black light inspections must show no defects in bond or structure of the silver, or the bearings will be rejected.

After plating, the silver surface is machined to the specified thickness and surface finish, provided with a thin coating of lead and

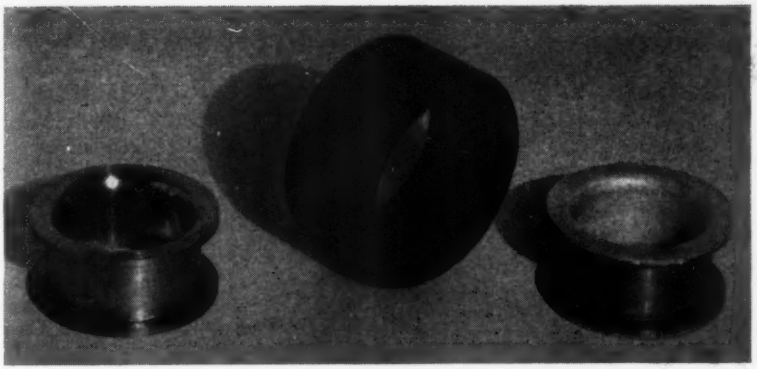

Fig. 3. Masking of steel shell. From left to right: unplated shell, mask, shell plated on inside and on flange after removal of mask

indium and heated at 320° F. This results in a silver-lead-indium surface. The lead acts as a lubricant during starting, and the indium protects the lead from the corrosive action of the lubricants under operating conditions.

Selective Plating

Only such areas of the steel backing as are to be used as bearing surfaces are plated. This requires adequate stop-off material. Most bearing backing is plated on one side only, the inside, in which case the outside and ends must be stopped off. The stop-off procedure is quite simple for such items in that a rubber tube or a formed rubber mold may be used. Items of complicated shape, such as the so-called "spider", calls for real skill in the development of stop-off molds and methods. Stop-off lacquers and paints may be used when rubber tubes or molds are not satisfactory. (See Figs. 3 and 4.)

Adhesion

The most important quality in a silver bearing is the strength of the bond between the silver and the steel back. A satisfactory bearing requires a bond strength equal to the tensile strength of the deposited metal. It is at this point that one of the most serious difficulties are encountered in that there are no adequate methods for inspection

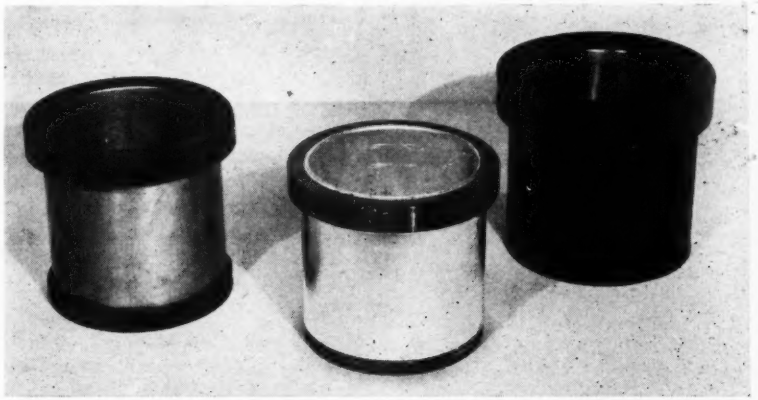

Fig. 4. Masks on steel shell. From left to right: unplated shell with rubber mask on ends, same shell plated on inside and outside (note dark areas of bare steel from which masks have been removed), masked steel shell ready for inside plating only

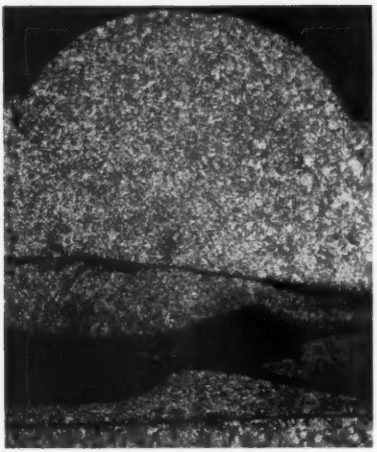

Fig. 5. Cross section of a very small blister with pimple. Note the lines parallel to the base. X100 reduced to X75

of the adhesion of the deposited metal on all bearings. One of the present A. E. S. Research Projects is concerned with finding satisfactory tests for adhesion.

The hammer and chisel test is used routinely on such bearings as are not damaged beyond repair by the test. Other

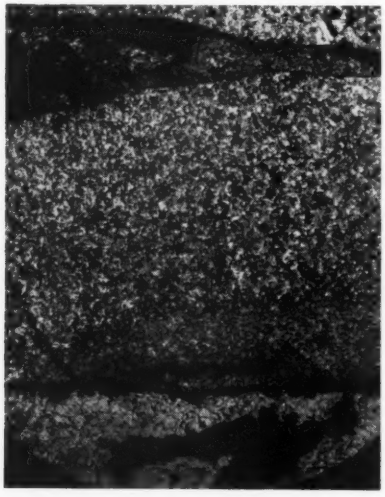

Fig. 6. Cross section of large blister. Note the line in the silver parallel to the base and the defect in the steel. X75 reduced to X38

bearings are tested by spot check which means sampling of two bearings out of every hundred, quartering, and testing them with the hammer and chisel. The lot they represent is accepted or rejected on the results of the test. Black light, X-ray, supersonics, the vibrator (an English development), the tensile machine, and modifications are other means for testing adhesion that may be employed.

One reason why the specifications call for heating at around 950° F for one hour is that it was thought that this treatment would provide a good test of the bond strength. This is true only when there are deep pits in the steel, or dirt or rust on its surface that hold moisture, or inclusions of certain foreign matter within the silver. In such cases, heating will cause volatilization and create sufficient pressure to blister the deposit (Figs. 5 and 6).

Other than this, heating does not reveal weak bond or absence of bond. The fact is that an originally weak bond may become perfect on heating. The main reason for heating is actually to assure the best possible bond strength. The very interesting observation was made in our studies on adhesion that long time at room temperature has much the same influence on bond strength as annealing. I shall return to this subject later in this paper.

Preparation of the Steel Surface for Plating

The procedure followed in the preparation of the steel surface for plating was: degreasing, immersion in soap solution for three to five minutes, alkali cleaning for five minutes or until the surface is free from water break, dipping in soda solution to prevent rusting. At this point the stop-off is applied, the bearings are put in holders and a contact wire is attached to each bearing.

The secondary cleaning cycle includes: alkali cleaning with or without reverse current, dipping in hydrochloric acid, striking with nickel or copper, silver striking and silver plating. Our preference has been a nickel strike. The bond strength to the "as plated" bearing is not always the best, but heating or long standing generally corrects any weakness. Bonds that can be

broken with a pull of a few hundred pounds per square inch shortly after plating, cannot be broken with 35,000 pounds per square inch after heating for 30 minutes at a temperature of between 800 and 1,000° F, or after standing for six months at room temperature.

There is no doubt that electrocleaning, either anodic or cathodic, will speed up the removal of grease or soap. However, cathodic current in some alkali cleaners is definitely detrimental to good bond between the steel and the nickel. Anodic current or no current is satisfactory in cleaning steel surfaces for plating if preceded by treatment either in a degreaser or in soap solution or in both.

Both anodic and cathodic treatments have been suggested. It is my experience with hydrochloric acid dips that nothing is gained by the use of cathodic current and that anodic current may be detrimental to good bond. This was demonstrated by the following experiment. Bearings were taken through our standard cleaning line, except for the acid dip. The lower third of each bearing was first placed in the acid as an anode, then the whole bearing was immersed in the acid without current for about 15 seconds. The treatment was continued following the standard procedure, except that no silver strike was used on the top third of the bearing. This permitted the plate to be lifted to provide a handle for testing of the bond at the center of the bearing. The adhesion tests showed inferior bonds to surfaces anodically treated in either hydrochloric or sulfuric acids, independently of whether nickel, copper or silver had been used for striking. In most instances, the deposited metal could be separated from the area to which the anodic current had been applied, but not from areas on which dipping only had been used.

Control of Thickness of the Silver Deposit

The cause for the greatest number of rejects was insufficient silver to meet minimum thickness specifications. The total weight of metal required may have been deposited on a bearing, yet on some areas the thickness was below the required minimum.

It was our practice to add about an extra 30 per cent to the average weight of silver. This may seem extravagant, but, since all excess silver is machined off and recovered, the only extra cost is for the plating time and the recovery which is much lower than the cost of a large number of rejects.

The important factors which determine the distribution of the plate are the size, shape and distance of the anode in relation to the cathode. A special plating setup is required for every size and shape of bearing. We had about forty different setups in regular production in addition to those needed for samples.

As a rule the anode was rotated inside a bearing which was plated on the I. D., and the bearing itself was rotated when the O. D. was to be plated. It makes a big difference in the distribution of current, i. e., of silver, over the bearing whether the revolving inside anode is off center or not. Thus, for example, on a quarter section cut from a bearing we found the silver thickness to vary from 0.040 to 0.063 inch, a variation of about 60 per cent. This bearing was plated at from 152 to 256 amperes per square foot in 90 minutes.

On a full sleeve bearing, the variation was from 0.030 to 0.043 inch or about 43%. This bearing was plated at an average current density of 250 amperes per square foot in one hour.

Deposition of Heavy Silver Deposits

"The deposit shall be uniform, dense, fine-grained, free from inclusions, blisters or other defects"—so say the specifications. To produce it is the second most important problem, perfect bond being the number one problem.

Twenty-five years ago Dr. Frank Mason of England read a paper before the Faraday Society entitled "A New Maximum Current Density in Commercial Silver Plating"[1] in which he suggested a current density of 8 amperes per square foot and claimed his "to be the first published process wherein such a large current density is used resulting in deposits of very fine crystalline structure."

British plating authorities in discussing

this paper said: "This heavy deposit at high speed is contrary to the law of nature." "I do not agree with Mr. Mason when he suggests that it is practical to plate with a high current density." "I do not agree with the views of Mr. Mason has put forward tonight. I think his proposal is outside the possibilities of practicabilities."

To plate a thickness of silver of 0.060 inch at a current density of 8 amperes per square foot would require 45 hours plating time. It is evident that much faster plating would have to be done, even at the risk of "violating the law of nature" if the needed production of silver plated bearings was to be achieved.

Experimental work in higher speed silver plating done a few years ago led me to make the statement[2]: "I do not know what the upper limits are. I do know that it is possible to plate silver at a current density of 200 amperes per square foot which would give a thickness of 0.0015 inch of silver in less than 3 minutes, but for general use this is not, at present, practical."

If the advocacy of a current density of 8 amperes per square foot brought down upon it the criticism of impracticability, it is not surprising that the suggestion to plate 25 times faster should meet with the same reception.

As most of us know, the factors that determine the current density which can be employed in plating are: solution composition (in particular the metal concentration and the brightener), the degree of agitation that is applied to the cathode, and the temperature of the solution. As these are increased, current densities may be raised. What the maximum current density is, I still do not know. Satisfactory deposits have now been produced experimentally at current densities as high as 600 amperes per square foot. There are many good reasons why such high plating speeds are not desirable. The higher the plating speed, the more precisely must be controlled every other plating factor.

Most of our bearing plating was done between 60 and 70 amperes per square foot. At 70 amperes per square foot 0.050 inch is deposited in 4 hours and 25 minutes. The bath composition and plating conditions were about as follows:

Silver	14–15 oz/gal
Potassium cyanide	13–14 oz/gal
Potassium carbonate	1–8 oz/gal
Temperature	90–100° F
Agitation	Anodes inside of the bearings rotate about 180 rpm, or the bearings rotate about 100 rpm.

Brightener was used and, as always in silver plating, was a very vital factor in the production of a satisfactory deposit. In my opinion, the most satisfactory brightener for the high speed silver plating solution is the ammonium thiosulfate type because, with the same plating conditions, a much higher current density may be used than when carbon disulfide type of brightener is employed. However, I do not think that I would recommend the thiosulfate type for the standard silver solution containing 3–4 oz/gal of silver.

References

[1]Trans. Faraday Soc. **16**, No. 3, 64 (1921).
[2]Proc. Am. Electroplaters' Soc. **1937**, 106.

(*To be concluded in October issue*)

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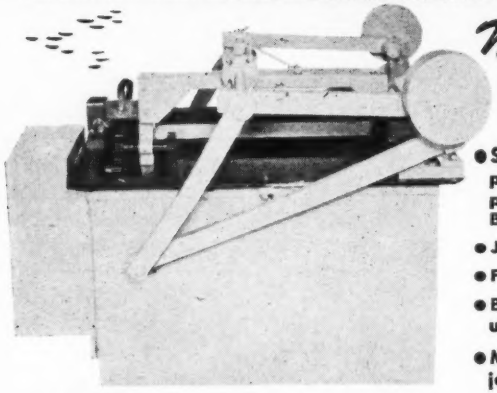

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ENVIRONMENTAL CONTROL of Metal Cleaning Processes

By F. A. PATTY
Industrial Hygiene Consultant
GENERAL MOTORS RESEARCH LABORATORIES—DETROIT, MICHIGAN

(Concluded from August Issue)

Water Cooled Condensers vs. Thermostats

Vapor degreasers may be further classified as those with and those without water-cooled condensers. Condensers on the safer operating equipment consist of water jackets or a set of pipe coils or both, extending around the tank at some distance from the top. Some vapor degreasers, designed to operate with tetrachloroethylene and without condenser units, depend upon a bimetallic theromostat control alone to keep the vapor within the tank. The use of a mechanical device as the sole means of keeping the vapor from overflowing the tank is open to criticism, and when the thermostat is placed within a few inches of the top of the tank, the device is not sufficiently quick and certain of action to be dependable and safe. The purpose of the condenser is to limit the vapor space above the boiling solvent to a definite height and prevent the escape of concentrated vapors into the room. The vertical distance between the lowest point at which vapors can escape from the degreasing machine and the normal vapor level is called the "free board." The free board should be a minimum of 15 inches and not less than one-half of the width of the machine. The temperature of that portion of the condenser which extends above the vapor line should be maintained above room temperature and below 110 degrees F. The effluent water should be regulated to within the same range. A temperature indicator or control is desirable.

Solvents

The preferred solvent for water-cooled degreasers is trichloroethylene, also called Perm-a-Chlor, Blacosolv, Circosolv, Cecolene, and Triad. Tetrachloroethylene, also called perchloroethylene, Perm-A-Kleen, and Phill-solv, can be used after the machines have been adjusted to suit the characteristics of the higher boiling solvent. Machines not equipped with water-cooled condensers are designed to operate with tetrachloroethylene only. They should not under any circumstance be operated with a more volatile degreasing solvent such as trichloroethylene.

Besides trichloroethylene and tetrachloroethylene, two other solvents have been used in water-cooled degreasers: carbon tetrachloride and ethylene dichloride. Because of its volatility, high toxicity, and susceptibility to hydrolysis into acid, carbon tetrachloride is not considered a suitable solvent in degreasing machines. Ethylene dichloride has been used by itself or mixed with trichloroethylene. Besides being toxic like all chlorinated hydrocarbons, it is also inflammable. Its flash point by the closed cup method is 56 degrees F. Vapor-air mixtures containing from 6.2 to 15.9 per cent by volume of ethylene dichloride explode with violence when ignited.

Trichloroethylene vs. Tetrachloroethylene

It may be in order here to discuss briefly these two solvents and to point out cer-

TABLE I

PROPERTIES OF TWO DEGREASING SOLVENTS

	Trichloroethylene	Tetrachloroethylene
Boiling point, degrees F.	189	250
Heat of evaporation at b.p., Btu/lb	103.1	90.1
Vapor pressure at 77 degrees F., mm mercury	76	23
Amount of vapor in "saturated" air of 77 degrees F., per cent by volume	10	3
Density of vapor at b.p. (air at same temperature = 1)	4.5	5.7
Density of vapor at b.p. (air at 77 degrees F. = 1)	3.7	4.3
Density of air saturated with vapor at 77 degrees F. (air at 77 degrees F. = 1)	1.35	1.1
Density of 2,000 ppm vapor-air mixture at 77 degrees F. (air at 77 degrees F. = 1)	1.007	1.01
Density of 2,000 ppm vapor-air mixture at 110 degrees F. (air at 77 degrees F. = 1)	0.94	0.94
Toxicity	Moderate	Moderate
Odor	Readily noticeable, not offensive to most persons	Moderately strong, unattractive, offensive to som persons
Inflammability	Difficult to ignite, no violent explosion	Not inflammable under any conditions
Ignition temperature, degrees F.	770	Does not ignite
Temperature at which pyrolysis may become significant (higher temperature should be avoided), degrees F.	248	284

tain characteristics that may have a bearing upon the choice of a degreasing liquid. These are listed in Table I.

The boiling points, which directly control the temperature of the work on leaving the machine, differ. While the parts leaving tetrachloroethylene are too hot to handle, their high temperature may be advantageous in a subsequent operation. The high boiling solvent is said to be more effective in driving moisture from small orifices and crevices. Also, it is possible to use it in machines without water-cooled condensers. Because of the lower heat of vaporization and higher boiling point of tetrachloroethylene, more vapor condenses per unit weight of metal being degreased. This is conducive to more efficient cleaning of light gauge material.

The higher temperatures required to boil dirty tetrachloroethylene may lead to more pyrolysis or decomposition of the solvent with resultant acid formation.

The lower vapor pressure of tetrachloroethylene limits the amount of vapor that can exist in the air without condensation to about 3 per cent at 77 degrees F. The density of such a vapor-air mixture, 1.1, is frequently of more practical importance than the usually quoted pure vapor density figure of 5.7. The latter would indicate that any escaping vapors would sink rapidly to the floor. As a matter of fact, the concentration of vapors escaping from a degreaser is rarely greater than 2,000 ppm by volume. The density of such a mixture is essentially that of air at the same temperatures. At the temperatures existing above and around a degreaser in operation, always above 100 degrees F., the vapor escaping from the machine is usually lighter than the surrounding air and rises rather than sinks. A 5-degree rise in temperature is sufficient to overcome the slightly increased density of a 0.2 per cent (2,000 ppm) vapor-air mixture and to cause it to rise from the surrounding room atmosphere.

Fatalities have resulted from the use of solvent degreasers. Intoxication results chiefly from inhalation of the vapors. It is doubtful that systemic industrial poisoning results from absorption of these materials through the skin of the hands, the skin irritation may result from defatting by

these as well as by other fat solvents. The odor of pure tetrachloroethylene is somewhat more pronounced and less attractive than that of trichloroethylene and may be advantageous as a warning agent.

Trichloroethylene at room temperature will not burn, but trichloroethylene vapors when heated above 110 degrees F., have a narrow inflammable range at around 20 per cent by volume. This range increases with temperature. Above 135 degrees F. it is from about 15 to 40 per cent by volume, and the ignition temperature is 770 degrees F. These conditions do not occur in plant atmospheres but may occur within a degreaser.

Trichloroethylene vapor does not explode violently under any circumstances but may burn slowly to form dense smoke and gases such as chlorine, hydrogen chloride and phosgene. Although tetrachloroethylene vapor does not ignite or burn, oils or greases accumulated during cleaning do. For that reason, sources of ignition, especially overheating with gas or electric heaters, should be avoided during distillation for sludge removal. Also, welding on or in a degreaser should be avoided when it contains any solvent. Temperatures above 248 degrees F. for trichloroethylene and 284 degrees F. for tetrachloroethylene may cause significant decomposition (pyrolysis) and should be avoided, except possibly if necessary during solvent recovery.

Stabilizers

Commercial degreasing solvents sold under trade names, usually contain a small amount of a material known as a stabilizer. The purpose of the stabilizer, frequently organic amines, is to combine with or prevent the formation of free hydrochloric acid that might result from (1) oxidation of the degreasing liquid in the presence of air, (2) hydrolysis in the presence of water, or (3) pyrolysis under the influence of high temperatures. Nearly all chlorinated solvents are to some extent subject to decomposition from these causes. For that reason, the stabilized solvents have been preferred where decomposition and resultant corrosion have presented a problem. Some of the stabilizers are highly toxic and may cause serious injury to health by inhalation or absorption through the skin. In the amounts supplied in commercial degreasing solvents, they have not, so far as I am aware, caused injury. However, the addition of concentrated stabilizer by unqualified men in the plant is a dangerous practice which should be discouraged. If a stabilized solvent is desired, it should be purchased and not made in the plant. If the solvent is suspected of being insufficiently stabilized or of having an acid reaction, it is a simple matter for the chemist to determine the acid combining power by titration with methyl orange as indicator. A well stabilized solvent has been found to take the addition of 15 to 20 per cent of its volume of 0.1 normal acid before it evidences an acid reaction. If the solvent is found to have an acid reaction, it is acceptable practice to add to it a small excess of soda ash, distil and recover the solvent, remove the sludge, wash the degreaser free from all traces of soda ash, and dry it completely before again filling it with solvent.

Some samples of stabilized tetrachloroethylene have been found to lose their stabilizer on distillation because the stabilizers are insufficiently volatile to distil or too volatile to condense with the solvent. When corrosion results from the use of unstabilized solvents or solvent which has lost its stabilizer in distillation or by neutralization by acid, it may prove helpful to suspend a small bag of anhydrous sodium carbonate, soda ash, or anhydrous sodium metasilicate in the boiling liquid. These chemicals should not be added loose to the bath except in preparation for distillation with sludge removal, otherwise troublesome deposits may form on the work.

Heat Source and Heat Controls

Degreasers may be heated by electricity, gas, or steam. Steam is usually preferred. Electricity and gas require thermostatic controls in the boiling chamber to prevent overheating. Gas fired units should be provided with a flue from the combustion chamber to remove products of combustion. Steam pressure should never exceed

25 psi for trichloroethylene and preferably should not be above 15 psi. Tetrachloroethylene requires pressures of up to 50 psi. All machines should have thermostatic controls located a few inches above the normal vapor level to shut off the source of heat if the vapor rises above the condenser.

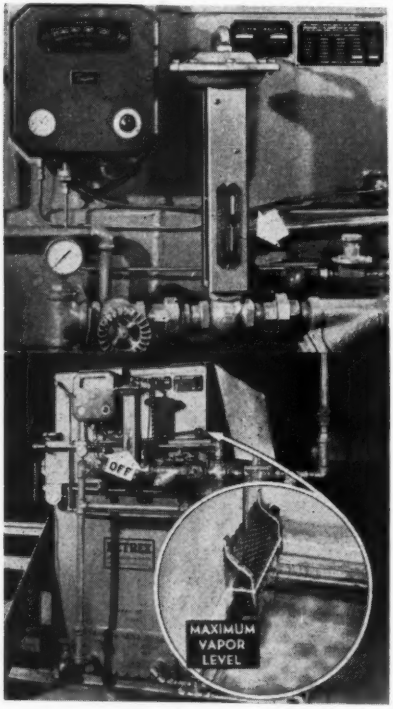


Fig. 14. Air operated vapor level control to shut off steam

The control device illustrated in Fig. 14 operates with compressed air. If for any reason the safety steam shut-off valve should be closed or be blocked by sludge so that sufficient steam for efficient operation is not available to the boiling chamber, production stops. This condition has occurred and, therefore, provision has been made for admission of steam for emergency operation until the valve can be cleaned or repaired. Many degreasers have been fitted with a by-pass steam line that anyone can open by merely turning a valve (Fig. 15). It does not appear altogether logical to provide a safety control and at the same time a parallel means for making its action useless. Such by-pass valves might better be locked in the closed position and the key placed in the hands of a responsible person, or the line removed and plugged so that the maintenance department's cooperation would be required to open the by-pass.

The control temperature of the boiling chamber may vary somewhat with the oil or grease which is being removed and, of course, must be somewhat above the boiling point of the clean solvent. The effect of mineral oil on the boiling point of degreasing solvents has been determined by one of the solvent manufacturers. With trichloroethylene, cleaning is advised when the boiling temperature reaches 195 degrees F.; with tetrachloroethylene, 260 degrees F. These temperatures correspond to about 25 to 30 per cent of contaminating oils in the solvents (Fig. 16).

Sludge Removal

Sludge and metal chips should be removed as often as necessary to prevent their accumulation. The period between cleanings may vary from a few days to a month, depending upon the nature and extent of the work. The solvent should be distilled off until the heating surface or element is nearly, but not quite exposed, or until the solvent vapors fail to rise to the collecting trough. After cooling, the oil and solvent should be drained off and the sludge removed through side doors provided at the bottom for the purpose. A fire hazard may exist during the cleaning of machines heated by gas or electricity, because the flash point of residual oil may be reached and because trichloroethylene itself is inflammable at elevated temperatures (Fig. 17). Following sludge and solvent removal, a degreaser must be thoroughly ventilated mechanically before any maintenance work is undertaken which involves flames or welding. A person should not be permitted to enter or place his head within a degreaser until all compartments have been blown free of vapors. When entering, he should wear an air-supplied hose mask respirator as well as a life line held by an attendant, because not only may very high and anes-

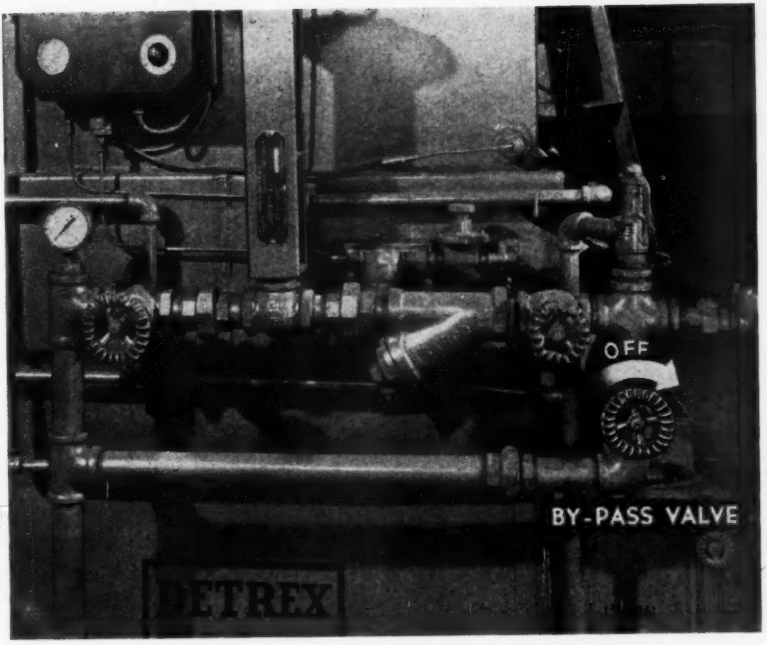


Fig. 15. By-pass around automatic steam control valve

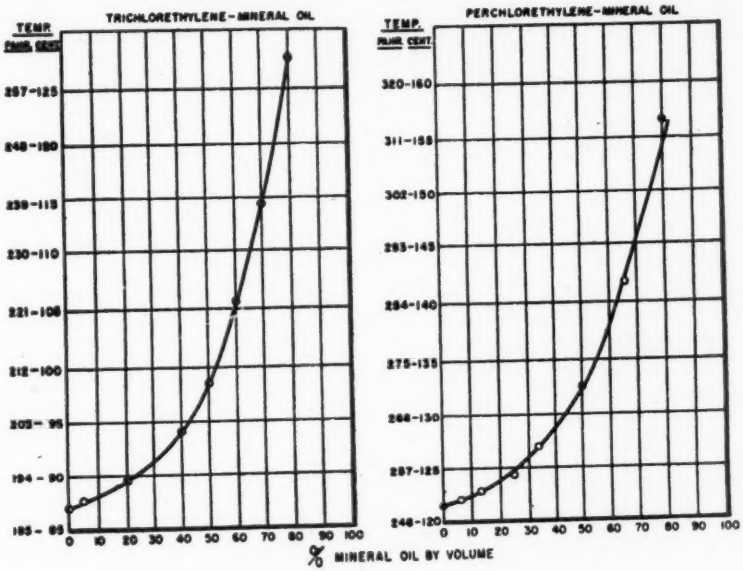


Fig. 16. Effect of mineral oil on boiling point of trichloroethylene and tetrachloroethylene

thetic concentrations of vapor be encountered, but also the oxygen content of the atmosphere may be insufficient to support life. Such an atmosphere may cause unconsciousness with little or no warning (Fig. 18).

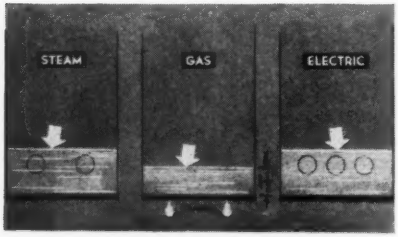


Fig. 17. Liquid level at end of distillation for sludge removal

Location of Equipment

Degreasers should be installed in large open departments with good general ventilation but away from drafts from open windows, spray booths, space heaters, ventilating duct openings, or fans. When degreasers are installed in pits, mechanical exhaust ventilation should be provided at the lowest part of the pit. It is not good practice to locate a degreaser beside an unventilated vat that evolves steam which may enter the degreaser. Open flames within perhaps 50 feet of a degreaser should have their products of combustion vented to the exterior, because if high concentrations of chlorinated solvent vapor come in contact with a flame, corrosive and irritant gases are formed.

Ventilation

A properly constructed and operated degreasing unit located in a room of over 30,000 cubic feet need not require a direct exhaust system and such a system may cause serious solvent loss. Also, a direct exhaust system may or may not offer satisfactory control for an improperly constructed or operated machine. Several fatalities have resulted from carelessness during the cleaning of degreasers, but there have been few injuries or fatalities attributed to exposures arising from the normal operation of degreasing equipment. Two fatalities recently attributed to prolonged exposure to trichloroethylene vapors arising from a degreasing machine, occurred where the degreasers were equipped with direct exhaust systems. This supports the general opinion that individual exhaust systems do not necessarily offer satisfactory control for faulty operating practices. General ventilation is a desirable safeguard even where direct exhaust systems have been installed. Any direct exhaust system should not pull air from the degreaser but should remove only the air rising above the degreaser if excessive solvent loss is to be avoided. Degreasers should be kept covered when not in use. However, frequent and abrupt covering and uncovering, which tends to fan the vapors out of the machine, is more wasteful of solvent than leaving the cover off until the job is finished. For the con-

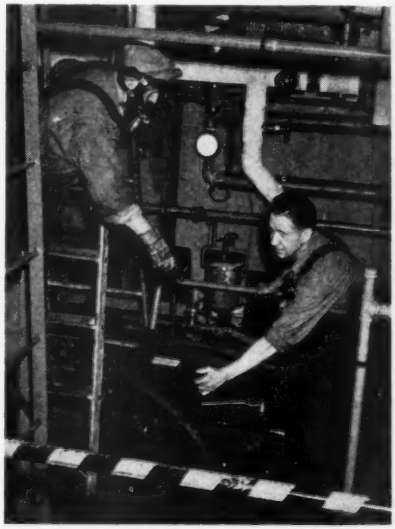


Fig. 18. Use of air supplied hose mask respirator during work on degreaser

veyorized and enclosed machine, a relatively small volume of air exhausted just inside the opening at which the operator stands for loading or unloading, causes a slight in-draft and controls the exposure without increasing the solvent loss (Fig. 19). A considerably greater volume of exhaust, correctly applied outside the machine, is likewise effective in control without causing excessive solvent loss (Fig. 20). A vertical slot at the top of an open degreaser offers satisfactory control but may increase solvent loss espe-

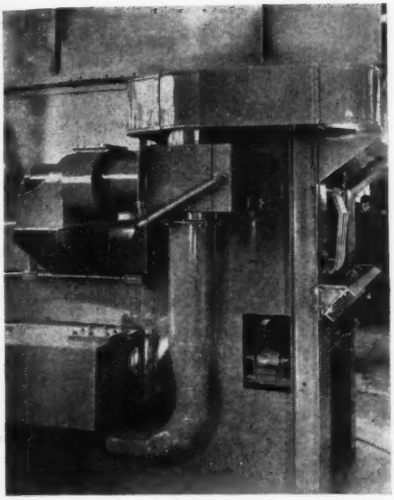


Fig. 19. Satisfactory exhaust hood for conveyorized degreaser. Exhaust applied just inside loading port

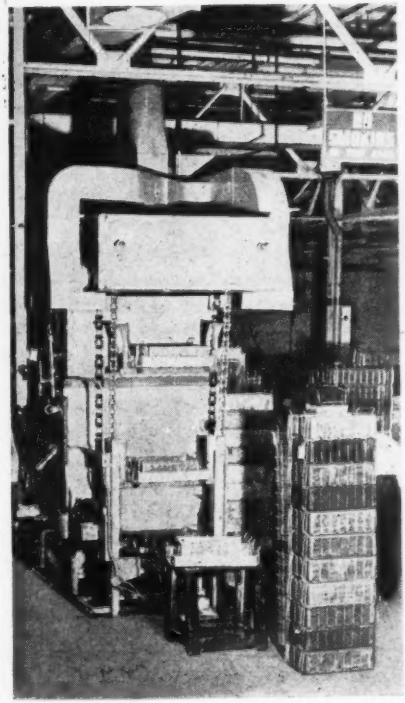


Fig. 20. Satisfactory exhaust hood with exhaust applied outside loading port

cially if the volume exceeds 30 CFM per square foot of tank surface (Fig. 21).

Common Causes of Solvent Loss

Five general and very common causes of solvent loss and atmospheric contamination may be pointed out:

1. *Air motion* of more than about 50 feet per minute across an open top degreaser, especially when directed lengthwise, causes excessive solvent loss. The greater the velocity, the more solvent becomes dispersed into the atmosphere. Drafts should be eliminated and degreasers should be covered when not in use.

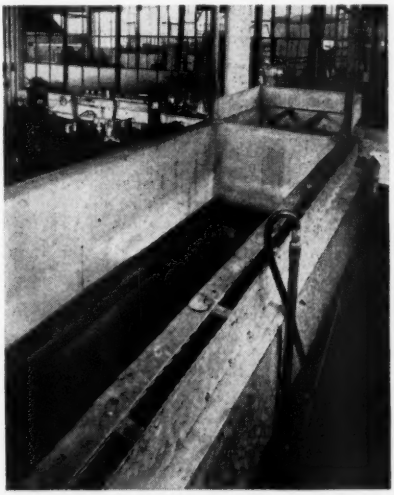


Fig. 21. Slot exhaust on open top degreaser

2. *Mechanical displacement of solvent vapor* may result from overloading, especially where there is insufficient clearance between the sides of the rack or the work and the machine. Also, when the load is large in relation to the heat input, it will cool and condense so much vapor as to cause the vapor level to fall and draw air into the degreaser.

The area above the vapor level in a degreaser is filled with a more or less rich solvent-air mixture. When the vapor level is lowered, the volume of this vapor-air mixture is increased by drawing in air from the room, and when the level is brought back to normal, some of the mixture is

orced out into the room. For instance, a one-foot fluctuation in a 3′ x 8′ degreaser displaces 24 cubic feet of solvent-air mixture into the room. The heat input should be sufficient to prevent the vapor line from falling below the bottom of the condenser under maximum load.

Machines not equipped with water condensers but only with bimetallic thermostats placed well up on the side of the machine, may displace an appreciable volume of vapor-air mixture each time the vapor rises to the thermostat. Where the change of vapor level exceeds six or eight inches in the normal operation, excessive solvent loss and air contamination will result. The greater the change in level and the more frequent its occurrence, the greater the solvent loss and air contamination.

3. *Improper Operation of Condenser.* All too frequently, excessive solvent loss can be traced to failure to open the valve to start the condenser operating before heat is applied to the boiling compartment.

It is also a mistake to run too much water through the condenser. The effluent water should never be below room temperature and may safely reach 110 degrees F. with trichloroethylene and 130 degrees F. with tetrachloroethylene. If the temperature of the condenser water falls below that of the room, water may be condensed from the room air and enter the solvent, causing a mixed vapor of water and solvent to form and float above the true vapor level. This condition, which leads to excessive solvent loss, is made apparent by a fog or white mist floating in the machine. Water from any other source such as the parts being degreased or a leaky condenser, will, of course, do the same thing. Water is further undesirable because of its tendency to produce corrosive acid by hydrolysis of the solvent.

The control of the temperature of the condenser should not be left to guesswork. Instead, the water flow should be adjusted by a key valve or other means to give the correct temperature reading on an indicator, and the water should be turned on full at the shut-off valve. This adjustment should be made either for the minimum temperature reached during operation under full load or for the maximum temperature during idling. It is desirable practice to provide a safety control to make it impossible to heat the boiling chamber before water is turned on in the condenser. This can be arranged in various ways, one of which is illustrated in Fig. 22.

4. *Speed of Work.* One of the hardest things to control on hand-operated open-top machines is the speed of the work. Ordinarily it should not exceed 11 or 12 feet per minute while work is being lowered into or raised out of the machine, as well as when it is moved within it. Higher speeds may cause vapor to be displaced or mixed with air by agitation. However, some conveyorized machines operate satisfactorily at twice this speed.

5. *Carry Out.* The work should always remain in the vapor until it appears dry, otherwise liquid solvent will be carried out to evaporate in the room air. Absorbents such as rope, cloth, or wood, should not be a part of the work, rack, or hoist. Solvent may also be carried out in tubes, cups, intricate shapes and recesses. This kind of work should be racked at an angle or tilted or rotated in the vapor zone until all liquid has been drained.

GENERAL CONSIDERATIONS

1. Prevent the offensive material from being dispersed into the general atmosphere (a) by enclosure, (b) by process ventilation as local as possible or, when this cannot be applied advantageously or effectively, (c) by use of general ventilation to dilute atmospheric contamination to below harmful levels.

2. Let control measures, such as layout and installation, receive careful consideration and be a part of the construction or alteration plans to hold at a minimum needlessly expensive additional alterations as well as ventilation monstrosities. When in doubt regarding the extent of atmospheric contamination or the most desirable method of control, consult one or more of the information sources available.

SUMMARY

Acid Cleaning. Gases, mists and vapors

must be controlled because they are (1) irritant and toxic and (2) corrosive to metals. The degree of control depends upon the location of the operation in relation to other operations, as well as upon whether the exposure causes moderate irritation or is immediately dangerous to health.

Alkali cleaning baths require protection from splash hazards and control of steam.

Emulsion cleaners range in content from relatively safe to more hazardous materials, and the protective measures required depend upon the composition of the cleaner.

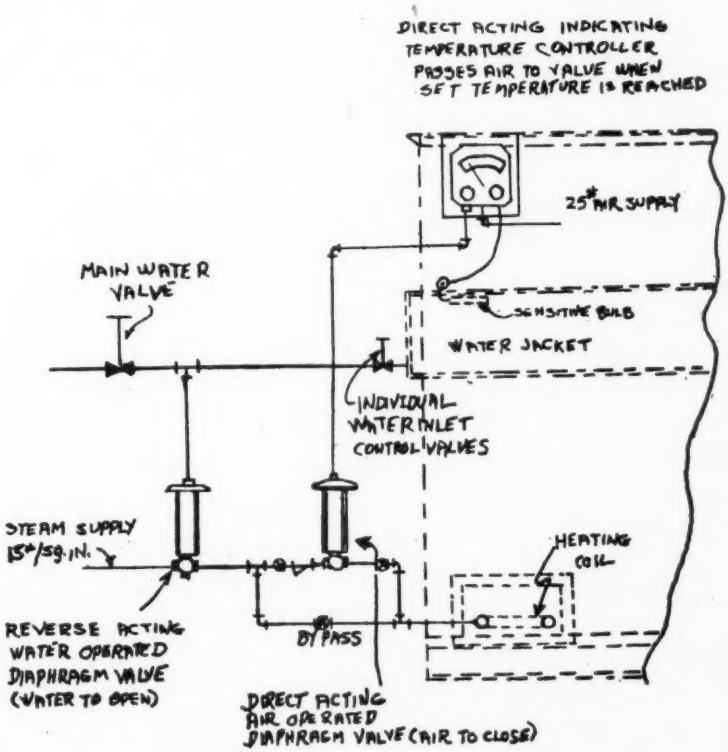
Cyanide dips necessitate control of escape of hydrogen cyanide and safeguards against the accidental addition of acid.

Burn-off requires control of smoke.

Molten salt and alkali baths require safeguarding from splash and splatter hazards and ventilation of any corrosive or offensive fumes.

Solvent degreasing necessitates the prevention of excessive solvent from evaporating into poorly ventilated surroundings. Fire and explosion hazards and exposures possibly harmful to health must be investigated and controlled.

Atmospheric concentrations of gas or vapors that are harmful to health are infinitely less than those in the inflammable range, but the effect is more obscure and less spectacular.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STEAM SUPPLY 15#/SQ. IN.
HEATING COIL
REVERSE ACTING WATER OPERATED DIAPHRAGM VALVE (WATER TO OPEN)
BY PASS
DIRECT ACTING AIR OPERATED DIAPHRAGM VALVE (AIR TO CLOSE)

Fig. 22. Plan of arrangement to require turning water into the condenser before admitting steam to heating coils

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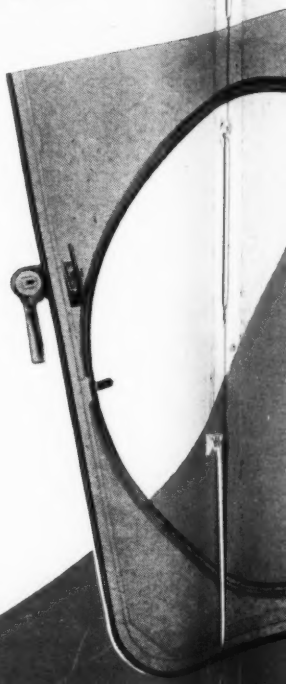

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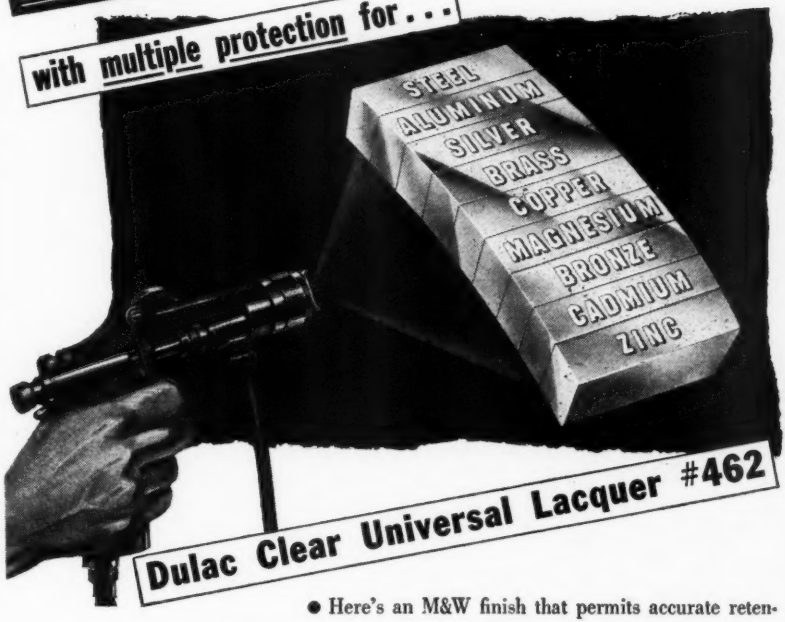

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III. The Calcium Polysulfide-Sodium Cyanide Method

A. E. S. Research Project No. 1

F. C. MATHERS
PROJECT DIRECTOR

ERNEST L. MARTIN
ASSOCIATE

Chemistry Department, University of Indiana
Bloomington, Indiana

Acknowledgement is due the Research Committee, Mr. E. C. Candee, American Brass Company, Chairman; the Research Directing Sub-Committee, Dr. R. M. Wick, Bethlehem Steel Corporation, and Dr. Louis Weisberg, Consulting Chemist, New York City, Chairman and Vice-Chairman respectively; and the Project Sub-Committee, Mr. L. E. Weeg, C. G. Conn, Ltd., Chairman, Mr. L. C. Borchert, Houdaille-Hershey Corporation, and Dr. H. J. Wiesner, C. G. Conn, Ltd., for their contribution to this project.

ABSTRACT

Copper has a very strong tendency to combine with sulfur. The copper sulfide formed is soluble in sodium or potassium cyanide. Since steel does not react to any extent with either sulfur or cyanide, copper can be readily stripped from steel by this method.

Results are given of a study of some of the variables affecting the rate of formation of copper sulfide and its dissolution in cyanide solutions.

An important development during this research is the discovery that "agricultural" lime sulfur, a relatively inexpensive material, is entirely satisfactory for this process.

The calcium polysulfide content of a bath can be maintained, except for drag-out, by the addition of sulfur which is readily soluble.

Efforts to prolong the life of the cyanide solutions with addition agents or by regeneration were unsuccessful. The use of mechanical methods to remove a portion of the copper sulfide film prior to cyanide treatment was partially successful.

INTRODUCTION

The reactions involved in the sulfide-cyanide method are given below:

$$Cu + CaS_x \rightarrow CuS + CaS_{x-1} \quad (1)$$

copper + calcium polysulfide → copper sulfide + calcium polysulfide

$$2CuS + 8NaCN \rightarrow 2Na_2Cu(CN)_3 + C_2N_2 + 2Na_2S \quad (2)$$

copper sulfide + sodium cyanide → sodium cupro-cyanide + cyanogen + sodium sulfide

For the regeneration of polysulfide:

$$CaS_{x-1} + S = CaS_x \quad (3)$$

calcium polysulfide + sulfur = calcium polysulfide

An investigation was made of some of the factors affecting this method of stripping copper, namely:

1. Concentration of the calcium polysulfide

2. Time of immersion in the polysulfide solution

3. Temperature of the polysulfide and cyanide solutions.

Cost is one of the major considerations in any stripping process and this factor guided the thinking in the early stages of this research. Since the sulfide solutions in general use by platers are relatively expensive, an effort was made to find a low cost substitute.

"Agricultural" lime sulfur, a form of calcium polysulfide, is used in tremendous quantities in the spraying of orchards and is a very cheap material. Preliminary test results with this material were comparable to those obtained with materials in general use by platers. Accordingly, further tests were conducted to evaluate this material completely.

A second factor contributing to the cost of this method is the large amount of sodium cyanide required to dissolve the copper sulfide. It will be noted in reaction (2) that there are required eight molecules of sodium cyanide to dissolve two molecules of copper sulfide. Thus, every gram of copper that is converted to copper sulfide requires for its dissolution 3.07 grams of sodium cyanide.

It was felt, therefore, that it would be a worthwhile accomplishment if some reduction could be achieved in the quantity of cyanide required. Accordingly, two principal lines of attack were followed: (1) the use of addition agents in the cyanide solution in order to prolong its useful life and (2) the use of mechanical means to remove as much of the copper sulfide as possible BEFORE the work is immersed in the cyanide solution.

EXPERIMENTAL

The data presented in the graphs and tables were obtained with "agricultural" lime sulfur of a sulfur content of 24% and a Baumé reading of 32–33 degrees. The calcium polysulfide, sodium cyanide and "agricultural" lime sulfur were commercial grades. No effort was made to purify them or to use chemically pure materials since it was felt that these precautions were not warranted. The chemicals added to the cyanide solutions, however, were CP grade.

The tests were run on small steel panels having a total area (both sides) of 2 square inches. These were copper plated in a Rochelle salt copper bath to a thickness of approximately 0.002 inch per side and were suspended in the test solutions by steel wire. One hundred millimeters of the sulfide and cyanide solutions were used. The levels were maintained constant at the elevated temperatures by frequent additions of distilled water. A large water bath was employed around the solutions to keep the temperature constant.

The general procedure for making a run was as follows: The previously weighed copper plated steel panel was immersed in the sulfide solution for a definite length of time, rinsed very thoroughly in water, dried and reweighed. It was then immersed in the sodium cyanide solution to dissolve the copper sulfide film, rinsed, dried and weighed again. The difference between the original weight of the copper plated panel and the third weighing (after immersion in the cyanide solution) represents the amount of copper removed. This weight difference can be converted to thickness of copper or to the amount of copper sulfide formed by the use of proper factors.

Effects of Temperature of Sulfiding Solution and Time of Immersion

In Figure 1 is shown the thickness of copper converted to copper sulfide for a series of concentrations of "agricultural" lime sulfur at several temperatures. The time of immersion in the sulfide solution was two minutes.

The curves show that the lower the temperature, the lower the rate of penetration or change of copper to copper sulfide. The graph further indicates that an increase in concentration up to 70% *i. e.*, 70 parts of the 32–33° Bé solution with 30 parts of water, increased the rate of penetration. Above this value, there was a decrease.

Since the curves show the optimum operating conditions for the lime sulfur to be (a) concentration of 70% and (b) tempera-

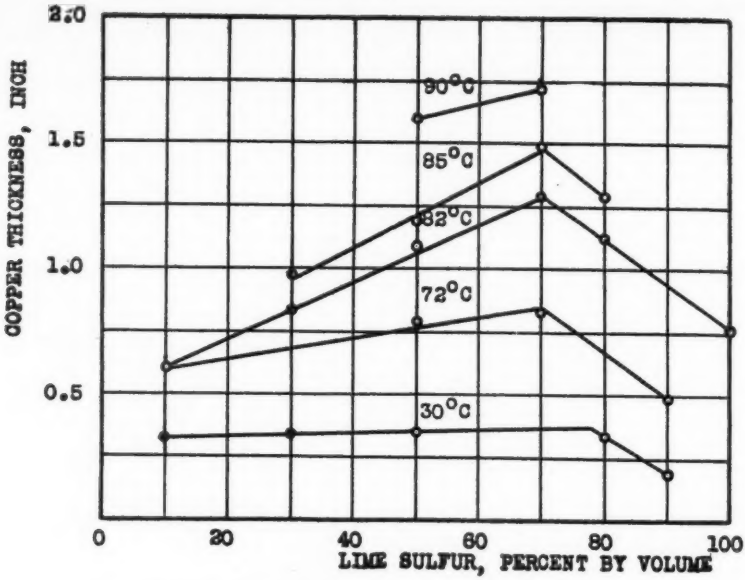

Fig. 1. Thickness of cast copper converted to copper sulfide during two-minute immersion in "agricultural" lime sulfur solutions

ture of 85° C (185° F) or higher, these were used in most of the subsequent experiments.

TABLE I

Effect of Immersion Time on Rate of Sulfiding of Copper

Solution—70% "agricultural" lime sulfur
Temperature—85° C (185 °F)

Immersion time minutes	Thickness of copper sulphided inch
2	0.0015
3	0.0019
5	0.0020
10	0.0024
210	0.0028

The depth of penetration with increase in immersion time is shown in Table I. It may be seen that the rate of formation of copper sulfide at this elevated temperature (85° C) is quite rapid during the first three minutes. Thereafter, the rate is appreciably slower. From a practical standpoint, this means that for the most rapid stripping of copper deposits, the immersion time in the sulfide solution should be comparatively short, of the order of three to five minutes. The sulfide treatment is followed by thorough rinsing in water and immersion in the cyanide solution. The cycle may be repeated if necessary.

A test run at 25° C (77° F) showed that six minutes were required for a penetration of 0.001 inch. At the end of three hours, 0.0018 inch copper had been removed.

Effect of Stripping on Base Metals

An important factor in this method of stripping copper from ferrous metals is the excellent condition in which the base metal is left after the copper has been taken off. A check was made to ascertain how much, if any, base metal was lost by prolonged immersion in the calcium polysulfide solution at an elevated temperature (82° C). The results are shown in Table II.

It is evident that losses are too small to require consideration. The surface was in good condition with no noticeable etching or pitting even after three hours of immersion.

TABLE II

Effect on Steel and Iron of Immersion in Lime Sulfur Solution

Solution—70% "agricultural" lime sulfur
Temperature—82° C (180° F)

Immersion time minutes	Weight loss in mg/2 sq. in.		
	Low carbon steel	High carbon steel	Malleable iron*
60	0.8	0.1	0.7
180	1.2	0.4	—

*polished

Effect of Addition Agents in the Sodium Cyanide Solution

When copper sulfide dissolves in sodium cyanide (reaction 2), copper is reduced to the cuprous state and one of the products formed is cyanogen (C_2N_2) whereby twenty-five per cent of the cyanide is lost. It appeared that the addition of some reducing agent might result in a saving of this cyanide. However, sodium sulfite which is a good reducing agent, had no appreciable effect in a concentration of 80 g/l (10.6 oz/gal). Other addition agents were tried with little or no improvement. The data in Table III summarize the results obtained in this study.

It is evident from Table III that there is a distinct advantage in operating a straight cyanide solution as hot as possible from the standpoint of solubility of copper sulfide. However, at very elevated temperatures, there is a strong tendency for the sodium cyanide to decompose and, for this reason, a compromise temperature range of 80–85° C (176–185° F) is recommended.

Some saving of cyanide is possible by raising the temperature to 95° C (203° F) when the solution is no longer active at lower temperatures.

It is interesting to note that at 70° C there is little difference in the quantities of copper sulfide dissolved in the cyanide solutions with and without addition agents. However, the solutions containing sulfites and nitrites show a lower rate of increase in solubility of copper sulfide with increased temperature than the straight soduim cyanide solution.

It was noted that a black precipitate, presumably copper sulfide, was deposited when a spent cyanide solution which had been operated at 95° C, was cooled. This precipitate redissolved when the bath was reheated. Removal of the precipitate by filtration of the cold solution did not increase the activity of the clear, reheated filtrate.

TABLE III

Effect of Addition Agents in Sodium Cyaniae Solution on Solubility of Copper Sulfide

Solution—120 g/l (1 lb/gal) NaCN

Addition		Copper dissolved, g/l		
Agent	Concentration g/l	70° C	85° C	90° C
None	—	42.6	50.1	70.0
Sodium sulfite	50	45.8	—	51.1
Sodium nitrite	100	46.3	—	54.2
Sodium acetate	100	44.1	—	—
Sodium ferro-cyanide	100	39.5	—	—

Electrolysis of the spent cyanide solution with an iron anode caused copper to be deposited on the cathode and produced some regeneration. Simultaneously, however, the cyanide was oxidized at the anode and this prevented the process from being successful.

Use of Mechanical Methods to Conserve Cyanide

In general, all attempts to conserve cyanide by the chemical means described above were of no avail. The possibility

still remained of removing some or all of the copper sulfide by mechanical means before immersing the piece in the cyanide solution. This would introduce a saving in cyanide proportional to the amount of copper sulfide removed mechanically.

There are a number of mechanical means which might be used for this purpose such as (1) a strong jet of water, (2) hand scrubbing with a brush, (3) an air blast and (4) tumbling. The success of any one of the aforementioned methods requires the copper sulfide film to be more or less non-adherent.

In this phase of the work, a strong jet of water was employed. Some typical results are shown in Table IV. It is evident that since only 20–40% of the total copper was removed by the strong water jet, the film was not held loosely enough. Further work with greatly improved results will be presented in the next report.

TABLE IV
Copper Sulfide Removal with Strong Water Jet

Time in sulfide solution minutes	Temperature of sulfide solution °C	Copper removed			
		With water jet gram	In cyanide solution gram	Total gram	Total inch
2	85	0.103	0.344	0.447	0.0015
180	25	0.181	0.344	0.525	0.0018
900	25	0.240	0.383	0.623	0.0021

SUMMARY

This portion of the study of the sulfide-cyanide method of stripping copper has led to the following conclusions:

1. "Agricultural" lime sulfur, having a sulfur content of approximately 24% and a Baumé reading of 32–33°, may be used satisfactorily in this process. It is a low cost substitute for the calcium polysulfide solutions commonly purchased for stripping of copper.

2. The optimum operating conditions for the lime sulfur treatment have been established. They are: (1) concentration—70% by volume of lime sulfur, 30% by volume of water, (2) temperature—85° C ± 5° (185° F ± 9°), (3) time of immersion—3 to 5 minutes.

3. The lime sulfur solution has little or no effect on carbon steel or malleable iron even on prolonged immersion at elevated temperatures.

4. The sodium cyanide solution used to dissolve the copper sulfide film should be operated hot for maximum efficiency. A temperature of 80–85°C (176–185° F) is recommended.

5. Some addition agents were tried but had no beneficial effect in prolonging the usefulness of cyanide solutions or regenerating them.

6. The use of a mechanical method for the removal of copper sulfide in order to conserve cyanide was partially successful.

The use of sodium polysulfide in the sulfide-cyanide method will be described in a subsequent report. Date on the stripping of copper from zinc alloy die castings will also be presented.

EDITOR'S NOTE: IT WILL BE NOTED THAT THI REPORT CONTAINS NO DATA ON THE RATE OF DE COMPOSITION OF EITHER THE CALCIUM SULFIDE BATH OR THE SODIUM CYANIDE BATH AT ANY TEMPERATURE. FOR INFORMATION ON THE DECOMPOSITION OF CYANIDE, THE READER IS REFERRED TO THE PAPER BY R. M. WICK, "THE DECOMPOSITION OF CYANIDE SOLUTIONS," THE MONTHLY REVIEW 19, NO. 10, 20–23 (APRIL 1933) IN WHICH THE CONCLUSIONS WERE REACHED THAT 45° C (115° F) "IS THE MAXIMUM TEMPERATURE FOR OPERATION IF ECONOMY OF CYANIDE IS IMPORTANT" AND THAT BELOW 65° C (149°F) IF "FOUND TO BE NOT OTHERWISE OBJECTIONABLE, AN ADDITION OF ALKALI WILL GREATLY REDUCE THE LOSS IN CYANIDE." IT IS ALSO SUGGESTED THAT IF THE STEEL ANODE HAD BEEN PLACED IN A POROUS CUP CONTAINING A SODIUM CARBONATE SOLUTION, THERE WOULD HAVE BEEN NO ANODIC OXIDATION OF THE CYANIDE ON ELECTROLYSIS.

RESEARCH NEWS

Research Committee and Executive Board Meeting

The Research Committee will meet in the Waterbury Club, Waterbury, Connecticut, on Friday, September 13, at 10:30 A. M. This meeting has been arranged so that the Research Committee can attend the Waterbury Branch meeting Friday evening. The Officers and members of the Research Committee will enjoy this opportunity of meeting a number of the New England members of the Society.

An Executive Board meeting being scheduled for the following day, the National Officers will undoubtedly plan to attend the Research Committee meeting and the Branch meeting and stay over for the Board meeting on Saturday.

Members of the Research Committee and the Executive Board who have not made hotel reservations are advised to accept Research Committee Chairman E. T. Candee's kind offer to make reservations for them.

PLATING INSTITUTE OFFERS NEW SERVICE TO INDUSTRY

In order to assist manufacturers in selecting the type of plating, rustproofing or metal finishing best suited to their purpose, *The Plating Institute*, 2237 Dime Building, Detroit, Michigan, has established a committee of experts to consult with and advise those interested.

Raymond H. Shock, Executive Secretary, states that many new metal finishing, plating and rustproofing processes were developed during the war for which local facilities are available, and it is the purpose of the Institute to help manufacturers facilitate their requirements by supplying information relative to processes and reliable sources to do the work.

There will be no charge for this service and it is hoped it will be used freely by all those whose products require plating or rustproofing.

LIBRARY COPIES RECEIVED

Three members have contributed to the drive to place copies of THE MONTHLY REVIEW and the *Proceedings* in strategically located libraries. They are John Acheson of the Toronto Branch, Clarence Anderson of the Milwaukee Branch and Harry M. Saltzberg of the Boston Branch.

Many thanks.

It is hoped that many more of our members will follow their good example.

REVIEW INCREASES FOEIGN SUBSCRIPTIONS

The Subscription Department of the MONTHLY REVIEW reports that there are now more that 70 subscriptions going to the U. S. S. R.

This is just one example of the rapidly increasing foreign subscriptions to the REVIEW, now that the war has ended.

Congratulations go to the various authors who supply the valuable reading material.

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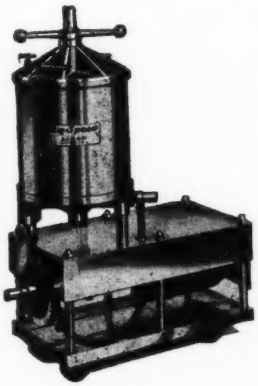

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By GEORGE B. HOGABOOM

Consultant, New Britain, Conn.

No. 2,403,821, July 9, 1946—Polishing Cloth—J. D. Morgan and R. E. Lowe, assigned to Cities Service Oil Co., New York, N. Y.

1. A cloth for cleaning and polishing metal surfaces comprising a soft and absorbent sheet impregnated with a polishing mixture consisting of from 5 to 10 per cent by weight of oleic acid, from 1 to 4 per cent by weight of triethanolamine, from 20 to 60 per cent by weight of magnesium oxide (light), from 15 to 45 per cent by weight of precipitated calcium carbonate and from 10 to 30 per cent of infusorial earth.

No. 2,404,289, July 16, 1946—Detergent Composition—W. B. Hicks and D. J. Saunders, assigned to The Solvay Process Company, New York, N. Y.

1. A detergent composition comprising (by weight) 40 to 50 parts sodium carbonate, 25 to 33 parts tetrasodium pyrophosphate, 2 to 7 parts trisodium phosphate, 2 to 7 parts sodium metasilicate and 1 to 3 parts of water-soluble, solid organic sulfonate detergent.

No. 2,404,298, July 16, 1946—Saponaceous Detergent Having Improved Hard-Water Characteristics—H. H. Kroll and M. Weisberg, assigned to Alrose Chemical Co., Cranston, R. I.

1. A detergent having improved hard water characteristics comprising a water-soluble organic amine, an amide an alkylol amine and a higher molecular weight carboxyacid, and a water-soluble soap, in ranges 5–20, 20–40 and 40–80 per cent, respectively, said percentages being based on the amount of these same three components, which detergent has the form of a bar or cake with a smooth uniform appearance and the smooth feel of bar soap and which is produced by heating the aforesaid components at substantially 125°–160° C for a period of substantially 45–15 minutes.

No. 2,404, 364, July 23, 1946—Apparatus for Recovering Metals—Thomas B. Cooper and William Schulz, assigned to Cooper Development Co., New York, N. Y.

1. An apparatus for reclaiming white metals from dross including a casing having a heating cavity, a cradle rotatably supported in said cavity, means of imparting rotary movement to the cradle, a receptacle having an upwardly and outwardly inclined side wall, said chamber closed to the atmosphere and removably fitted in said cradle and adapted to contain molten metal

to be separated, an agitator mounted to rotate freely within receptacle, and means for retarding the agitator relative to the rotation of the receptacle and the molten metal.

No. 2,404,367, July 23, 1946—Water Purification—W. W. Durant and W. A. Blain, assigned to American Cyanamid Co., New York, N. Y.

1. A process for purifying water, the steps which comprise passing water containing less than 20 ppm of total solids through hydrogen zeolite and then through an anion-active material which has been treated with a reagent to adjust the *p*H of effluent water flowing from said anion-active material to about 7.5, said reagent being an aqueous solution of a carbonate and bicarbonate and having a *p*H of about 7.5.

No. 2,404,948, July 30, 1946—Control of Electrolytic Processes—C. P. Crocco, assigned to Westinghouse Electric Corporation, East Pittsburgh, Pa.

An object of the present invention is to provide a control system for continuous electrolytic process which shall function to coordinate the speed and the current density in the process.

Another object of the invention is to provide a control system for an electrolytic process for continuously treating a continuous moving length of material which shall function so to coordinate the current density and the speed of travel of the length of the material as to produce uniform treatment of the length of material regardless of changes in the speed of travel of the length of material.

Another object of the invention is to provide a control system for an electrolytic process for continuously treating a continuously moving length of material which shall function to provide any desired ratio between the speed of the length of material and the current density in the process and which shall function to vary the ratio of speed to current density in response to changes of the speed of the length of material.

2. In a control system for an electrolytic process, an electric motor for causing a length of material to travel through the process, first generator means for energizing the motor, second generator means for supplying current to the process, said second generator means having an excitation circuit connected to be energized in accordance with the voltage of the first generator means, third generator means connected in said excitation circuit, a first pilot generator operable to develop a potential proportional to the speed of the material, second pilot generator means operable to develop a potential proportional to the current supplied to the process, regulator means operable to control the excitation of the third generator means, said regulator means having one operating circuit energized in accordance with the potential of the first pilot generator and a second operating circuit energized in accordance with the potential of the second pilot generator, first variable resistance means operable to vary the excitation of the first generator means, and second variable resistance means actuated in conjunction with said first variable resistance means for varying the effectiveness of the potential of the second pilot generator on said second operating circuit of the regulator means, thereby to provide for varying the ratio between speed and the current as the speed of travel is varied.

A. S. T. E. Semi-Annual Convention, October 10–12

The American Society of Tool Engineers has announced, through its president, *A. M. Sargent*, preliminary plans for the largest Semi-Annual National Convention in the Society's history, to be held at Pittsburgh, Pennsylvania, October 10, 11, 12, 1946. Convention headquarters will be the 17th Floor of the Hotel William Penn.

Seminars on timely technical subjects, visits to industrial plants in the Pittsburgh area employing new production techniques, showings of engineering films, the Semi-Annual Banquet, and many special events make up the comprehensive convention agenda, according to Sargent.

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The Surface Treatment of Hot-Dip Galvanized Coatings Preparatory to Painting and Its Relation to Corrosion Resistance

E. F. PELLOWE and F. F. POLLAK. *Sheet Metal Inds.*, **23**, 82–84, 85 (January 1946).

Six methods of surface treatment to improve adhesion of paint on hot-dip galvanized coatings are: natural weathering, mechanical roughening, galvannealing, etching, depositing lead or copper metal deposits or black etching, and phosphatizing. Each is evaluated.

●

Metal Cleaning, Finishing, Protection A Symposium

Metal Progress, **48**, 957–969 (October 1945).

Group of articles includes:

Process Engineering of Surface Conditioning and Finish, by C. ONKSEN.

Blast Cleaning of Metal, by A. L. GARDNER.

Surface Preparation of Cast Iron, by J. H. SHOEMAKER.

Improvements in Zinc and Nickel Coatings, by M. B. DIGGIN.

Improvements in Other Protective Metallic Plates, by R. B. SALTONSTALL.

Oxide Finishes on Copper, Steel and Aluminum, by W. R. MEYER.

Chromate Finishes on Zinc, Cadmium and Magnesium, by R. M. THOMAS.

Development of aluminized enamel to replace brass, copper, and nickel in headlamp reflectors and various improved nickel plating processes are described. A semi-bright and bright cobalt-nickel plate with 18% cobalt reaches 600 Vickers hardness, with 1% cobalt 371–500. A new semi-bright nickel bath contains only nickel chloride and acetate and obtains Vickers 37–380 and elongation of 8 to 10% in ½ inch. This is used in building up ordnance parts and for plating cladding and rolling steels, stereotypes and electrotypes and for electroforming. A composite nickel-zinc plate, and a nickel-iron alloy plate which is harder than either nickel or iron and has a much higher tensile strength, are described. When plated with tin and heat treated nickel has better corrosion resistance than hot-dipped or electroplated tin.

●

The Electrodeposition of Tin-Zinc Alloys

R. M. ANGLES. *J. Electrodepos. Tech. Soc.*, **21**, 45–64 (1946).

The results of an investigation on the deposition of tin-zinc alloys ranging in composition from 92/8 to 28/72, are discussed. Instructions are given for the deposition of the alloy containing 78% tin which appears to be the most serviceable. Chemical methods for the analytical con-

trol of the plating bath and alloy deposit are given.

●

Improvement in Ductility of Hot Dip Zinc Coatings

W. PUNGEL and R. STENKHOFF. *Stahl und Eisen* **64**, 720–725 (1944).

Experiments aimed at producing ductile hot dip zinc coatings on sheet and wire are described with conclusions and recommendations.

●

Properties and Methods of Applying Phosphate Coatings

H. JAEGER. *Galvano*, **14**, 14–15 (October 1945); *C. A.* 40, 801 (February 20, 1946).

The films produced by the Parkerizing process contain 49.2 P_2O_5, 14.6 Mn and 27 Fe. The Russian Digofat process films contain 49.6 P_2O_5, 15.5 Mn, 0.57 Fe, 1.28 SO_4 and 0.17 F.

●

Resistivity of Thin Metallic Films

A. VAN ITTERBEEK and L. DE GREVE. *Nature*, **156**, 634-635 (November 1945); *Mond Gen. Refer. Sheet* No. 459, 14 (November 1945).

Results are given of a study of the resistivity of nickel films 20–70 μ thick at between $-$ 236° C and $+$ 400° C.

●

Electrolytic Bright Galvanizing

B. WULLHORST. *Mitt. Forsh. Inst. Edelmetalle Staatl. Hohere Fachschule Schwabisch Gmund.* **1942**, *No. 7*, 12–27 (1942); *Chem. Zentr.*, **114**, 1817 (1943); *Materials and Methods*, **22**, 1514 (1945).

The influence of different S compounds and of Ge, V, Ag, Ni, Fe, Co, Hg, Cd, Mo and Mn additions on the brightness of coatings was investigated. The influence of the metals depends not only on their type but also on their concentration and the depositing conditions. The deposits were examined with regard to their reflection and corrosion resistance. Detrimental to Zn deposition are Ge, V and Ag while small amounts of Ni or Mo increase the brightness. Sulfide S, particularly in connection with Mn addition in the baths, produces bright deposits while neither sulfites nor thiosulfates have any effect.

●

Cleaning and Electroplate Finishing of Beryllium-Copper Components

E. E. HALLS. *Metal Treatment*, **12**, 71–85 (Summer 1945).

Corrosion resistance of beryllium-copper alloys is discussed at length with comparative tables, showing also resistance of nickel-silver and nickel-copper alloys. Salt-spray and immersion tests are described. Processes for removing machine lubricants, oils and grease at intermediate or final stages of production, and for removing oxide and scale, particularly with sulphuric acid followed by acid dichromate solution, are given.

For electrical purposes, gold, silver or silver-rhodium are used, for normal protection and retention of a neat, light-colored appearance, nickel is usual with nickel-chromium preferable for complete resistance to attack over long periods.

●

Failure of Spring Loops by Stress-Corrosion

R. W. PARSONS. *Metal Progress*, **48**, 1310–1311 (December 1945).

"Pre-loaded" springs (coils wound tight against each other) of heat treated SAE 1065 spring wire requiring pickling and Parkerizing as final finish, broke by corroded transverse crack on inner surface of coil after Parkerizing. Tests were made and it was concluded that cracks were caused by stress corrosion in the pickling or Parkerizing vats. Painting of springs solved the problem. Without the magnetic flux test, it might have been concluded that 100% pre-flexing and elimination of the pickle had produced a satisfactory article, but the shallow cracks likely to be present would have made an inferior device with lowered fatigue resistance. Stress analysis

presented in April issue of *Metal Progress* by Brewer and Ihren completed the picture.

●

Wax Masking for Selective Copper Plating

C. E. ERNEST. *Metal Progress*, **48**, 1099–1101 (November 1945).

Gears, formerly rough turned, plated all over, returned to machining for removal of copper, carburized, machined again, then hardened, are now machined complete, selectively plated using wax masking, carburized and hardened. This not only saves time and transportation, but contributes to high standards of precision. Wax chosen and process are described.

●

Rectification and Surface-Hardening of Screw Threads by Electrodeposition

E. T. A. C. Tech. Memorandum, 3 pp (February 1945); *The Nickel Bull.*, **18**, 99 (July 1945).

The memorandum gives full details of recommended procedure for:—(1) electrodeposition of nickel for rectification of worn or over-machined threads; (2) electrodeposition of nickel plus chromium on screwed members for prevention of scoring; (3) surface-hardening by deposition of chromium and application of the process to screw gauges.

●

Methods for Determining Film-Thickness of Protective Coatings, Espically of 10μ

D. SCHENK. *Korrosion u. Metallschutz*, **19**, 1–5 (1943); *J. Inst. Metals & Metall. Abs.*, **12**, 327 (1945).

Three methods are described by which it is possible to measure coating thicknesses to 0.2 μ. The first is an electrical method in which the capacity of a portion of an insulating film between an applied mercury electrode and the underlying metallic base is measured by the change in resonance setting of a loosely coupled oscillator-receiver combination. Equation is given. The second method, applicable to metallic coatings on metals (especially on Fe), depends on the weakening of X-rays reflected at the interface between base and coating varying with the absorption in the coating. In the third method, the difference in the height to which a conical plug goes through a ring before and after coating is a measure of film thickness. This is particularly useful for calibration in the foregoing methods.

●

The "Topograph" Surface-Finish Measuring Instrument

ANON. Engineering, **159**, 427–428 (1945); *Bull. Iron & Steel Inst.* No. 117, 115A (Sept. 1945).

A detailed description of an instrument for evaluating surface finish which operates on a simple pneumatic principle and gives a pen record of an enlarged profile of the surface irregularities along a selected straight line. Irregularities of the order of 2 microinches are readily detected.

●

A Method of Revealing Microstructure of Nickel Deposits on Steel

R. STOKES. *Metallurgia* **33**, 21–22 (November 1945).

A suitable etching procedure was sought for studying the microstructure of nickel deposits on steel. It was necessary to find an etching reagent which would etch the Ni only or the Ni and steel at the same rate. Typical microphotographs are shown.

●

Recent Investigations of the Electrolytic Polishing of Metals

R. PIONTELLI, D. PORTA and L. ARDUINI. *Ricerca Sci.*, **14**, 156–160 (1943); *Chem. Zentr.*, **114**, 2203 (1943); *J. Inst. Metals & Metall. Abs.*, **12**, 319–320 (1945).

Experiments on the current density-voltage relation and the oscillographic record of the anode potential led to the conclusion that the optimum conditions for electrolytic polishing do not coincide with a stable passive state of the metal surface. If the

current density is constant, a progressive concentration of reaction products in the anode layer takes place with time; this leads to the loosening of a film of almost insoluble substances. The anode potential increases simultaneously and, if electrolysis is continued, gas evolution occurs which sets a limit to the polishing of the surface.

●

Nickel Dipping

G. H. McINTYRE. *Finish*, **3**, 37–40 (January 1946).

Adequate control is stressed. Time of immersion, sequence, and methods of rinsing before and after the nickel flash, interval of exposure to air between each step in the process, thickness of nickel coating, type of steel surface treated, proper removal of sludge have important bearing on quality of coating. Large scale production as well as research have indicated the effectiveness of the conditions and sequence of operation outlined.

●

The Electric Properties of Thin Layers of Annealed Nickel as a Function of Their Thickness

A. COLOMBANI. *Compt. rend.*, **214**, 794–795 (1942); *J. Inst. Metals & Metall. Abs.*, **12**, 241–242 (1945).

Thin layers of nickel were prepared by cathodic sputtering in pure hydrogen and annealed in vacuo at 410° C for 5 months. Below 220 mμ thickness, annealing caused an increase in resistance and above this thickness, a decrease in resistance. Ohm's law applies for all thicknesses studied (above 40mμ). For each thickness (t), a coefficient (α) of temperature effect on electrical conductivity applies. Between 40 and 500 mμ, α is a linear function of the thickness. Below 220 mμ the conductivity of layers increases with t, and at 220 mμ the temperature coefficient is practically zero. Above 220 mμ α becomes constant and of the same order of magnitude (4×10^{-3}) as that for ordinary metal. X-ray analysis shows that the thicker layers have the cubic structure of ordinary nickel. Absorption measurements by the microphotometer are very weak (0.21) and about constant below 90 mμ. Beginning at 100 mμ they increase abruptly to attain a practically constant value (2.8) on appearance of the metallic state. These measurements indicate that layers below 220 mμ in thickness do not possess the properties of metal. Between 220 and 500 mμ the metallic state gradually appears, and above 500 mμ the characteristics are those of ordinary nickel and are independent of the thickness. These studies show that electrical and magnetic properties vary with structure.

●

Corrosion Protection by Phosphatization—a Review

M. A. STREICHER. *Corrosion*, **1**, 219–227 (December 1945).

Chemistry of phosphatization, properties of phosphatizing solution, surface pretreatment, characteristics of the coat, and industrial applications are reviewed. An historical note on the process is added. Bibliography.

●

Investigation into the Influence of Ultrasonics Upon the Electrodeposition of Copper and Zinc

T. RUMMEL and K. SCHMITT. *Korrosion u. Metallschutz*, **19**, 101–104 (1943).

A partial picture of the effect of ultrasonics on conditions of deposition and structure of deposits is presented in a report of experiments in plating copper and zinc on copper with and without treatment of the cathode with supersonic waves, different current densities being used while all other variables remained constant. Lower current efficiency, coarsening of grain and discoloration of deposit resulted. Formation of hydrogen bubbles and their tenacious adhesion to the cathode had a certain cavitational effect. Grayish-black patterns in the zinc plate were due to distribution of zinc dust between zinc crystals. Light-colored zones corresponded to oscillation nodes and dark zones to oscillation bulges. These patterns will

appear in the deposition of all metals which, unlike copper, do not possess very high crystallizability under difficult conditions. Chemical tests should be run for porosity in order to ascertain whether in the dark zones the continuity of the zinc particles is sufficient to give satisfactory corrosion protection, or whether there are fine cracks, as appears to be the case under the microscope. Tables give full experimental data and graphs show decrease of current efficiency resulting from the sound treatment. Photo-micrographs show the structure of the deposits and the pattern formation in the zinc plate.

●

Taking it Off?

G. BLACK. *Metal Finishing*, **43**, 457–458 (1945).

Current methods of stripping metallic coatings are briefly reviewed, including stripping of cadmium, brass, bronze, copper, zinc, gold and silver from steel, copper from nonferrrous metals, chromium from steel or nickel, and nickel from ferrous and nonferrous metals. Solutions are given.

●

Electrodeposition and Related Fields

E. W. JONES and L. M. MORSE. *Record Chem. Progress*, **6**, 35–41 (July-October 1945).

Brief survey of the more significant developments in the plating and related fields since the middle nineteen-thirties for scientific workers in other fields. Thirty-six articles are referred to.

●

Glycerine and Metal Treatment

G. LEFFINGWELL and M. A. LESSOR. *Materials & Methods*, **22**, 1432–1434 (1945).

Use of glycerine for quenching, plating, cleaning, polishing, soldering and corrosion-inhibiting applications is described. References are given to recent technical and patent literature offering instances of use of glycerine in iron, chromium, zinc, nickel, manganese, molybdenum and tungsten plating to increase throwing power. Its use in electropolishing stainless steel is also mentioned. Bibliography.

●

Practical Gas Chromizing of Small Steel Parts

V. I. ARKHAROV. *Stal* (Moscow), **3**, 33–35 (1943).

Data on the gas chromizing of small steel parts, up to 0.8 inch in diameter and up to 6 inches in length, are presented. The chromized steels were low alloy constructional steels including 4–4.7 nickel—1.3–1.7 chromium steel, medium and high carbon steels.

●

Application of Chlorates as Oxidizers in Phosphating

F. ROSETEUTSCHER. *Korrosion und Metallschutz*, **20**, 165–166 (1944).

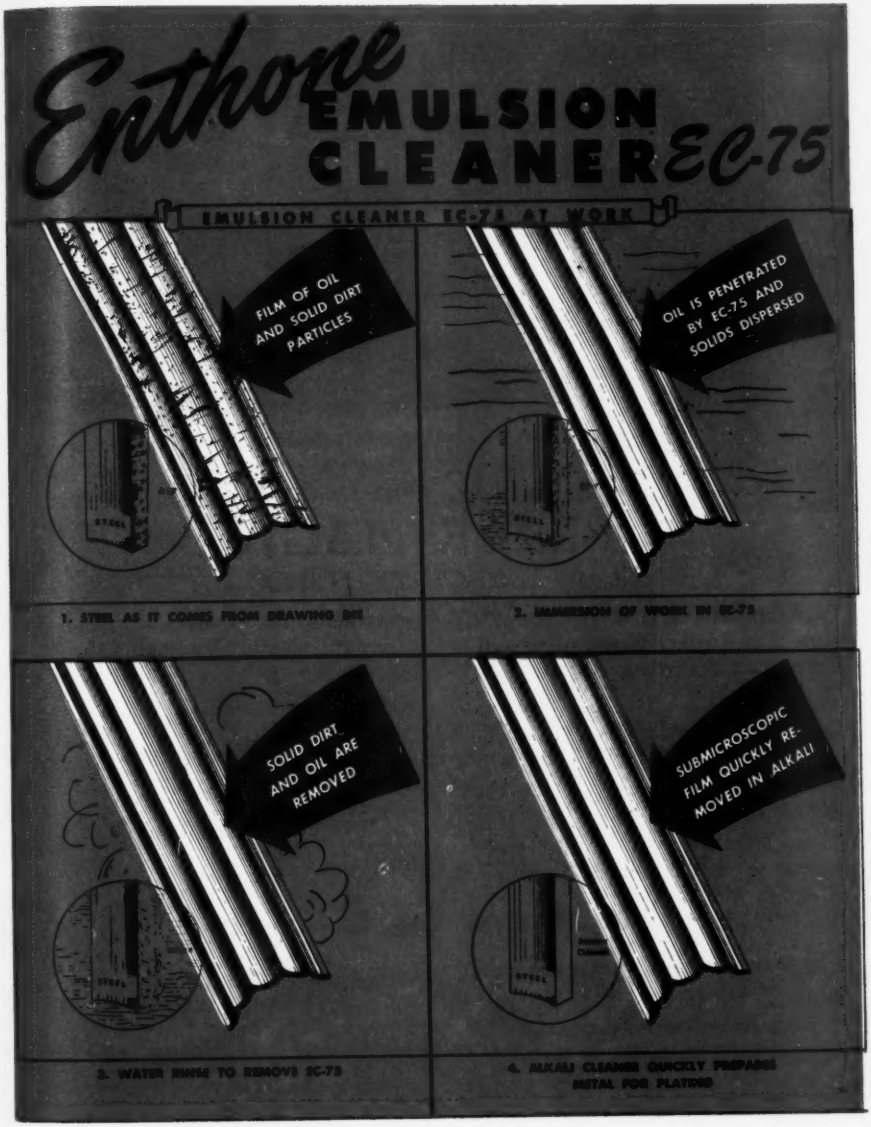
The reaction mechanism of chlorates added to phosphating baths as oxidizing agents is discussed. The advantages of such baths include: no break-in period; no special linings for tanks; very low and constant iron content of bath; ease of maintaining effectiveness of bath; thin, flexible coatings rapidly formed; low phosphoric acid consumption; suitability of coatings for cold drawing operations.

●

A Sulfur Print Method for the Study of Crack Growth in the Corrosion-Fatigue of Metals

R. C. BRUMFIELD. *A. S. T. M.* Preprint, **28**, 1–10 (1945).

The value of the sulfur print has been established for the study of crack distribution, profile shapes, depths of penetration, and the rate of crack growth. A similar procedure might facilitate study of the relative merits of materials, surface finishes, coatings and treatments in retarding crack growth and hence corrosion-fatigue damage. Equipment and procedure used by author in experiments are described.


Enthone
EMULSION CLEANER EC-75
EMULSION CLEANER EC-75 AT WORK
FILM OF OIL AND SOLID DIRT PARTICLES
OIL IS PENETRATED BY EC-75 AND SOLIDS DISPERSED
SOLID DIRT AND OIL ARE REMOVED
SUBMICROSCOPIC FILM QUICKLY REMOVED IN ALKALI
STEEL
1. STEEL AS IT COMES FROM DRAWING DIE
2. IMMERSION OF WORK IN EC-75
3. WATER RINSE TO REMOVE EC-75
4. ALKALI CLEANER QUICKLY PREPARES METAL FOR PLATING

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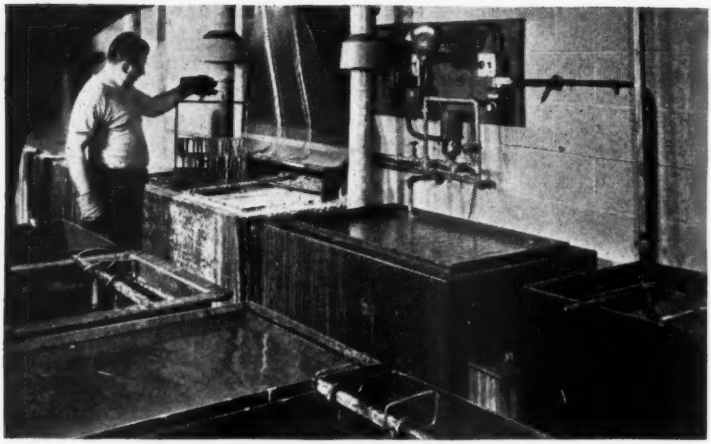

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BLACK-MAGIC is the choice of a nation-wide list of users because of its ease of installation, simplicity of operation and attractive finish. Installations personally supervised by qualified engineers.

The single-bath **BLACK-MAGIC** is a deep-penetrating (.0001″) process that gives iron and all steels except stainless a dense black that won't rub off. This finish is very flexible; forming may follow processing. **BLACK-MAGIC** is an effective rust inhibitor, also a fine bond for paints and lacquers. Chemical reaction at 300° F.

There is an excellent **BLACK-MAGIC** bath for zinc base die castings and thin sheet stampings such as grommets, eyelets, buttons, etc. Still other **BLACK-MAGIC** baths impart a rich black to copper, brass and bronzes. Send for samples and the "Black Book," which tells all!

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A glass-base protective spray coat for stoves, mufflers, office files—any steel or brass product exposed to extreme heat (up to 1000° F.), abrasion, corrosion—or wherever a durable finish of great beauty is desired. Spray it on and dry at 200° F. Then bake at 350° F. in any industrial oven. Soft eggshell finishes in all colors. Sample on request.

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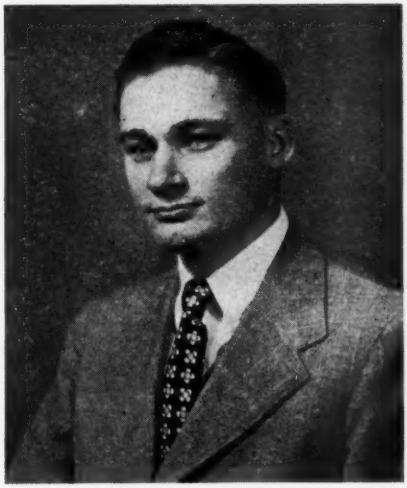
PUTNAM JOINS REVIEW STAFF

We are pleased to announce the appointment of Allan Ray Putnam as Advertising Manager, succeeding W. C. Pinkerton who resigned July first.

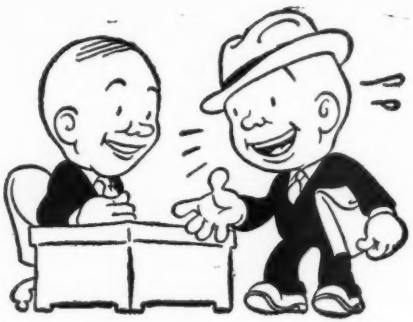
Mr. Putnam majored in Marketing at the Wharton School of Finance and Commerce, University of Pennsylvania and received his degree of B.S. in Economics from that school. He was commissioned in the Army Air Forces in 1942 and served variously in instructional, administrative, personnel, fiscal and command capacities. He was relieved from active duty in June with the rank of Captain.

Mr. Putnam will be actively engaged in the expansion of the advertising program of the MONTHLY REVIEW, and is planning to visit the present advertisers and advertising agencies during the coming months.



"A" BOMB BOYS BREAK BREAD

Manhattan Project scientists meet for Luncheon during 1946 A. E. S. Convention in Pittsburgh. Reading clockwise, beginning extreme left; W. L. Pinner, Detroit Branch S. G. Bart, Newark Branch; W. A. Hopkins, New York Branch; P. F. LoPresti, Rochester Branch; D. L. Patrick, Indianapolis Branch; W. M. Tucker, Rochester Branch; C. F. Robison, Hartford Branch; M. M. Beckwith, Indianapolis Branch; Charles C. Conley, Jackson-Lansing Branch; Louis Weisberg, New York Branch; A. K. Graham, Philadelphia Branch; L. C. Borchert, Chicago Branch; D. Gardner Foulke, Detroit Branch; Anthony C. Suleski of New York City; Anthony J. Fusco, Newark Branch; and W. A. Wesley, Newark Branch



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CINCINNATI BRANCH

The regular monthly meeting of the Cincinnati Branch was held on Wednesday, June 10, at the Engineering Society Headquarters, President H. E. NICE presiding.

Major item of business was the election of Officers, the following being unanimously chosen for the coming year:

President—AUGUST SCHWERING, Auto Sun Products Co.

Vice-President—EARL ROBBINS, Estate Stove Co.

Secy. & Treas.—CHARLES NUZUM, Schaible Company.

Librarian—W. S. CHIPMAN, W. S. Chipman Supply Co.

Board of Managers—JOHN DAYMUDE, Crosley Corp., WM. EHLEN, Stolle Corp., W. B. STODDARD, JR., Champion Paper & Fibre Co., and H. E. NICE, Harshaw Chemical Co.

It was arranged that a meeting of the Officers, Managers and interested members be held on July 17 for the purpose of making plans for the Year 1946–1947.

H. E. NICE, *Past President.*

•

HARTFORD BRANCH

The May meeting of the Hartford Branch was held Monday the 20th at the Hotel Bond. President TED VOYDA opened the meeting with a few remarks and turned it over to Technical Chairman ART LOGOZZO. Following an introduction, which really was not needed, MR. RALPH MCCAHAN, one of our own Branch members, delivered an excellent talk on High Speed Copper. He proved the contention of many that there is much valuable information right in the Branches which should be brought out. The forty members and guests who attended were well rewarded with a fine discourse.

F. W. SMITH, *Secretary.*

•

HARTFORD BRANCH

The June meeting was held as a sports event at the Stanley Golf Course, New Britain, Connecticut, on Monday, June 3, 1946. The members enjoyed golf in the afternoon and early evening. At 7:30 P. M. a delicious dinner was served at "The Hedges" for 35 members and guests. The evening ended with card playing that was enjoyed by all.

This event wound up the affairs of the Hartford Branch until September.

F. W. SMITH, *Secretary.*

•

CHICAGO BRANCH

The regular monthly meeting on Friday, July 12th, at the Atlantic Hotel was devoted to the reports of the Branch Delegates on the proceedings at the Pittsburgh Convention. J. W. HANLON covered the business meeting of the Society. MARION LONGFIELD gave a brief discussion of the technical papers presented.

We were honored by the presence of MR. FRANK SAVAGE of Kuehne Manufacturing Co., Mattoon, Ill., the new President of the Society. He gave us an excellent picture

of the financial status of the Society, and outlined the budget for the coming year In connection with the MONTHLY REVIEW, he stressed the fact that the editorial matter was 30% greater during the past year than at any previous time. He also said that the Society and the Executive Secretary intend to maintain the high standard of literary excellence.

Mr. Savage also discussed the Research Program at considerable length, covering the work done by the Project Directors at the colleges and universities which the Research Committee has chosen for placement of the various problems, and emphasized that this type of undertaking has never before been attempted on such a scale by any technical society. To keep the endeavor alive, serious cooperation must be forthcoming from every Branch and every member.

OWEN TOWNER, Chairman of the Membership Committee, impressed upon the Branch that it must increase its membership by at least 50 per cent during the ensuing year.

For the second straight meeting, there were no questions in the Question Box. The Chair commented that the calibre of the membership must be high indeed.

G. STUART KRENTEL,
Review Correspondent.

●

SYDNEY BRANCH

The Twenty-seventh Regular Meeting was held on Tuesday, 9 July 1946, at the Chamber of Manufacturers.

In the absence of the President, the chair was taken by Vice-President E. WRIGHT. There were 25 members and three visitors present.

One new member was elected and welcomed to the Branch. Six members were suspended for non-payment of dues.

After the business session, the meeting was handed over to Librarian F. HEARD, who introduced Mr. E. BEVAN who spoke on "Electrics as Applied to the Plating Industry" and gave his listeners complete data concerning the electrical side of plating.

J. R. GODFREY, *Secretary.*

SAN FRANCISCO BRANCH

The July meeting was held at St. Julien Cafe in San Francisco on the 11th. Eighteen members and two guests attended. In spite of the meat shortage, a very fine steak dinner was enjoyed by all. One application for membership was received, passed by the Board of Managers, and unanimously approved by the members.

A motion was approved to notify the Secretary of the Los Angeles Branch that the San Francisco Branch pledges its support in bringing the 1948 National Convention to his city.

Reports were made by the two Delegates, R. PATTENGER and F. CAVALLERA on the Convention at Pittsburgh.

F. W. HUNTINGTON, *Secretary.*

●

SOUTHEASTERN BRANCH

The regular monthly meeting was held in the Belmont Restaurant, 98 Luckie St. on Thursday, June 13. The meeting was called to order with 14 members present, Mr. R. E. NORMAN presiding.

Following a discussion as to the amount of entrance fee to be paid by transfer members, it was decided they should pay the difference between the amount paid the Branch from which they were being transferred and our fee of ten dollars. The five members attending the National Convention were asked to give account of the proceedings and happenings at the next meeting.

MR. WOOLFOLK of Birmingham talked about the membership drive and stressed the necessity of having qualified speakers at each meeting to maintain interest among the members.

MR. CARSON predicted that the South will lead the entire country in improvements in electroplating and research in a few years, and emphasized the effect mass production will have when adopted. He also thought we should be one of the largest Branches of the society in the country in a year or two.

First Vice-President AWTREY was appointed press agent to see that notices of all meetings etc., get publicity through the press with

MR. WOOLPOLK taking care of the Birmingham papers. It was decided that all members were on the Membership Committee and would expend some effort in obtaining new members.

WM. T. WEYMOUTH,
Secretary and Treasurer.

●

SOUTHEASTERN BRANCH

The regular meeting was held on Thursday, July 11 at the Pullman Shops, Atlanta, with 14 members present.

On CLEM HOHNER'S motion it was decided that a copy of the minutes of this meeting be mailed to our Birmingham members who found it inconvenient to attend this time.

MR. AWTREY suggested that the Branch order twenty-five lapel buttons for the members desiring them. This was approved.

Members that attended the national convention informed us that our Temporary Charter had been granted and that we will be known as the "Southeastern Branch."

This privilege was granted after quite a bit of convincing by our delegates.

Our speaker for the evening was MR. MICHAEL F. WIEDL, JR., Managing Editor of the Ernest H. Abernathy Publishing Co., Inc, who was introduced by CLEM HOHNER. MR. WIEDL gave a very interesting talk on the prospects of the South becoming one of the great manufacturing centers of the Country. What is needed is enough confidence in ourselves to develop the things we already have. He pointed to raw materials such as cotton which we raise and weave into cloth and then send somewhere else to be made into finished products which are then sold back to us at a good profit (cotton buffs for instance). He mentioned that with all the clay we have in Georgia, there is but one large manufacturer of clay products; similarly, steel, bearings, machinery, etc., could be made right here with a little extra effort.

The meeting was adjourned with a vote of thanks to MR. WIEDL and MR. HOHNER.

WM. T. WEYMOUTH,
Secretary and Treasurer.

PHILADELPHIA BRANCH

At the request of PRESIDENT ORLIK, the Branch Officers met at the home of GEORGE GEHLING, 5001 N. Tulip St., Philadelphia, on July 18th.

One application for membership was referred to the Board of Managers. Five applicants were elected to membership. The resignations of three members were accepted.

There was much discussion of the advisability of holding an Annual Meeting and Banquet because of the high rates charged and the scarcity of food. The final decision will be made after receipt of a more detailed report at the next meeting.

PAUL MENTZER, SR., *Secretary.*

●

PHILADELPHIA BRANCH

The Officers of Philadelphia Branch met at the home of NAT. VERRELLE, 1856 E. Clementine St., Philadelphia, on Thursday, August 8th with PRESIDENT ORLICK in the chair.

There was one application, one election to membership and one in-transfer from Detroit Branch.

After much discussion, a motion was passed by a 5 to 4 vote to the effect that the Branch will not have an Annual Meeting and Banquet. However, there will be a Saturday afternoon Educational Session and Luncheon in November.

It was further decided that the Branch buy the *Proceedings* for the Free Library, and that the Editor mail the "Quaker City Reminder" to all local libraries and plating shops.

PAUL MENTZER, SR., *Secretary.*

ERRATA!

On pages 649 and 653 of the June issue are announced new Technical Bulletins issued by General Chemical Company, 40 Rector Street, New York 6, N. Y. The Bulletin on Plating of Lead-Tin Alloys of Low Tin Content is designated at LTF–1, and the one on Zinc Fluoborate Solutions as ZF–1 and not the reverse as erroneously stated.

Our regrets for the mistake.

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YES, you can actually multiply the life of your hot and cold rinse tanks four times or more, by coating them inside and out with Tygon Plastic Paint Coatings.

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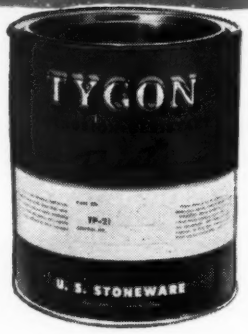

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Akron 9, Ohio

S. S. JOHNSTON

Chairman, Membership Committee

ELECTIONS

CHICAGO BRANCH

John J. Russell, Ekco Products Co., Research Laboratory, 1949 N. Cicero Ave., Chicago 30, Ill.

George G. Duncan, 903 E. 81st St., Chicago 30, Ill.

Harold Bielenberg, Sears-Roebuck & Co., Testing Laboratory, 925 S. Homan Ave., Chicago 7, Ill.

HARTFORD BRANCH

Joseph P. McInerney, W & S Blackinton Co., 24 Randolph Ave., Meriden, Conn.

David Momson, Jr., Russell & Erwin Mfg. Co., New Britain, Conn.

Alldis E. Shailer, Arrigoni Hotel, Middletown, Conn.

MONTREAL BRANCH

P. M. Coady, 216 Westminister Ave., Montreal West, Canada.

J. D. Fairburn, R. C. A. Victor Co., Chemical Department, 1001 Lenoir St., Montreal 30, Canada.

APPLICATIONS

CHICAGO BRANCH

Robert M. Wilcox, Minonk, Ill.

George W. Kerns, Dearborn Brass Co., Cedar Rapids, Iowa.

Jack Closs, 4073 N. Kenmore Ave., Chicago 13, Ill.

Frank Neul, 2916 Fitch Ave., Chicago 45, Ill.

Arthur A. Jenks, 1645 Carroll Ave., Chicago 12, Ill.

George L. Stutz, 2910 Eastwood Ave., Chicago 25, Ill.

Gilbert Valentine, 230 N. Canal St., Chicago 6, Ill.

Fred H. Kletka, Kuehne Mfg. Co., Mattoon, Ill.

HARTFORD BRANCH

Albert H. Gerlach, 88 Francis Ave., Hartford, Conn.

PHILADELPHIA BRANCH

Robert L. Farren, Jr., 29 Grier St., Hatboro, Pa.

William L. Keating, 317 Virginia Ave., Wilmington, Del.
J. Latimer Lee, Greenville, Del.
Samuel Pollack, 2610 Beulah St., Philadelphia 48, Pa.
Joseph E. Rotchild, 1602 S. 6th St., Philadelphia 48, Pa.

SAN FRANCISCO BRANCH
Frank R. Fernandez, 2526 Telegraph Ave., Oakland 12, Calif.

SYDNEY BRANCH
W. H. Millward, 49 Crump St., Mortdale, Sydney, N. S. W., Australia.
D. A. Carpenter, 6 Wetherill St., Sidcombe North, Sydney, Australia.
T. O. Kolts, Lawrence Smith & Co., Ltd., 19 Regent St., Sydney, Australia.
E. D. Terry, 12 Nolan Ave., Westmead, Sydney, N. S. W., Australia.

NEW YORK BRANCH
Walter Schilling, American Airlines, Inc., N. Y.

TRANSFERS

A. H. Clem from Detroit Branch to Philadelphia Branch
H. P. Munger from Detroit Branch to Pittsburgh Branch
C. Rott from Detroit Branch to Chicago Branch
D. L. Ewing from Detroit Branch to Jackson-Lansing Branch
W. McCord from Detroit Branch to Newark Branch
R. D. McAleer from Detroit Branch to Bridgeport Branch
Clarence Norris from Detroit Branch to Cleveland Branch
Geo. Perkins from Detroit Branch to New York Branch
Glen Walker from Sydney Branch to Melbourne Branch
Jack Semby Wright from Sydney Branch to Melbourne Branch

RESIGNATIONS

CHICAGO BRANCH
T. H. Westby

DETROIT BRANCH
J. Burkholder
A. T. Dunn
C. Lindenmyer
C. W. Morris
L. E. Honigman
C. S. Slack
P. Sauder

HARTFORD BRANCH
Clarence L. Lewis, Jr.

NEW YORK BRANCH
Vincent J. Marchese

TWIN CITY BRANCH
Walter J. Jordan
W. M. Wodzynski

SUSPENSIONS

DETROIT BRANCH
H. J. Bock
J. Boyd
L. A. Clark
J. D. Collins
W. Greene
H. Stengel
A. A. Subject
S. Thum

HARTFORD BRANCH
Edward Maietta

SYDNEY BRANCH
H. J. Bailey
A. R. Flett
G. Rose
A. Cornell
N. H. Kent
R. M. J. Wade

REINSTATEMENTS

DETROIT BRANCH
J. L. Germaine
E. G. Sosnowski

NEW YORK BRANCH
Ralph Kaplan
Abraham Mitnitsky

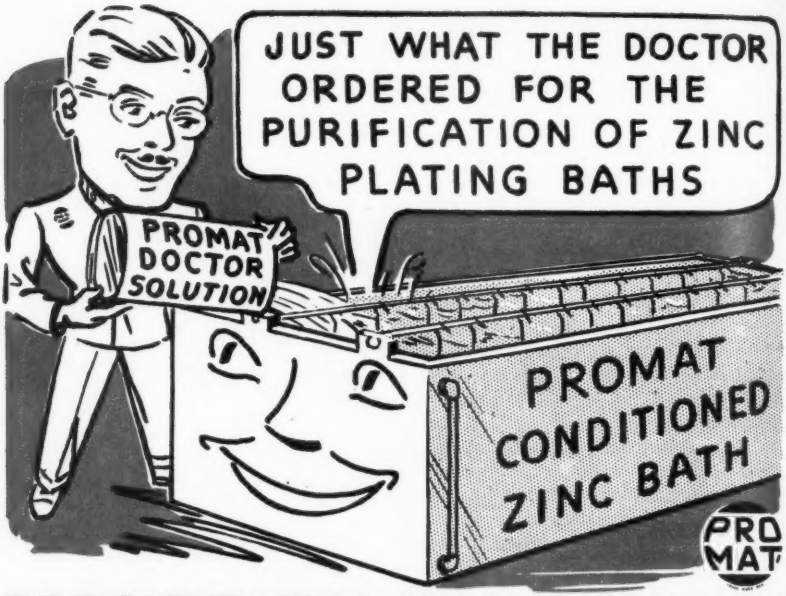
DEATHS

MILWAUKEE BRANCH
Anton Chlosta

MEMBERSHIP CHART

BRANCH	May 1946	Change in Membership	Percent Change
FIRST GROUP			
BRIDGEPORT	124	+ 9½	+ 7.7
NEW YORK	201	+12	+ 6.0
PHILADELPHIA	170	+ 6½	+ 3.8
HARTFORD	134	+ 3½	+ 2.6
TORONTO	131	+ 3	+ 2.3
LOS ANGELES	181	+ 4	+ 2.2
CHICAGO	359	+ 7½	+ 2.1
WATERBURY	128	+ 2½	+ 2.0
BOSTON	168	+ 1	+ 0.6
CLEVELAND	177	— 2	— 1.1
NEWARK	243	— 8	— 3.3
DETROIT	440	—37½	— 8.5
SECOND GROUP			
INDIANAPOLIS	90	+ 9	+10.0
PITTSBURGH	97	+ 8	+ 8.2
DAYTON	87	+ 3	+ 3.4
BUFFALO	87	+ 1	+ 1.1
GRAND RAPIDS	116	+ 1	+ 0.9
JACKSON-LANSING	85	+ ½	+ 0.6
SPRINGFIELD	82	....	....
ROCHESTER	97	....	....
BALTIMORE-WASH	114	....	....
ST. LOUIS	122	....	....
PROV.-ATTLEBORO	122	— 1	— 0.8
MILWAUKEE	120	— 1	— 0.8
SYDNEY	82	— 2	— 2.4
NEW HAVEN	110	— 3	— 2.7
THIRD GROUP			
SAN FRANCISCO	64	+ 6	+ 9.4
SYRACUSE	64	+ 5	+ 7.8
ST. JOSEPH VALLEY	60	+ 2½	+ 4.2
COLUMBUS	34	+ 1	+ 2.9
LANCASTER	38	+ 1	+ 2.6
MELBOURNE	59	+ 1	+ 1.7
TWIN CITY	72	+ 1	+ 1.4
ADELAIDE	37	....	....
ROCKFORD	58	....	....
CINCINNATI	58	....	....
TOLEDO	60	....	....
MONTREAL	61	— 5	— 8.2

Membership May 1, 1946:	4,527	Gain in Membership:	31
Membership August 15, 1946:	4,558	Percent Gain:	0.7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PRO MAT

PRECIPITATES HEAVY METALS

NOW AVAILABLE. Promat Doctor Solution to serve industry in the conditioning and purification of any cyanide zinc plating bath—previously sold only as a part of the Promat Zinc Plating Processes. An extremely stable liquid product—easily distributed in the bath—precipitates heavy metal impurities—improves deposit and "range" of cyanide zinc baths.

LOW COST. Initial charge is 8 c.c. per gallon of electrolyte—approximately two gallons per one thousand gallons—additions for maintenance (approximately .03 c.c. per ampere hours)—less than 15c per 1,000 ampere per shift. Simple tests indicate requirements. Complete instructions with initial orders. Available f.o.b. Waukegan, Illinois—30 gallon drums or 12 gallon carboys—$2.03 per gallon.

Representatives in principal cities.

PROMAT DIVISION—Poor & Company

851 SOUTH MARKET STREET WAUKEGAN, ILLINOIS

"Lip service" is the kind that promises *much*, but actually delivers *little* . . .

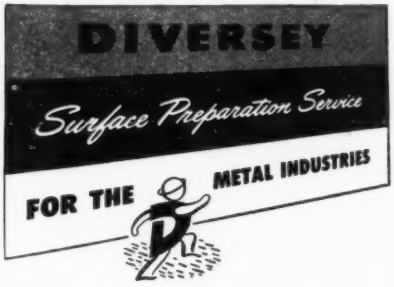
The Diversey D-Man doesn't work that way . . . because his job has just begun when he has persuaded you to give Diversey products a trial.

Usually on the very day that Diversey drum or barrel ordered rolls into your plant, you'll find the Diversey D-Man on hand decked out in his overalls. And he'll stay on the job until he has fully instructed your plant men in the proper use of Diversey products or licked the problems confronting you.

A Trained Specialist

Yes, the Diversey D-Man is much more than merely a salesman. He's a *trained* specialist in the technique of preparing metal surfaces for further processing. Each new man joining Diversey is first given intensive classroom instruction . . . and he must pass his "final exams."

Yes, it takes this kind of "shirt-sleeve and overalls" service to really deliver results. Any wonder more and more plants everywhere are looking to Diversey for *all* their metal preparation requirements? Metal Industries Dept., THE DIVERSEY CORPORATION, 53 W. Jackson Blvd., Chicago 4, Ill.



DIVERSEY PRODUCTS FOR THE ELECTROPLATER

No. 12—The anodic cleaner for steel. Removes tenacious deposits prior to bright plating. Minimizes foam blanket.

No. 22—A vigorous heavy duty product for soak tank and barrel type cleaning. Rapidly wets and emulsifies dirt, grease, and oil. Free rinsing.

No. 44—A medium duty cleaner particularly designed for soak cleaning of brass and zinc base die castings. Effective as a barrel cleaner prior to burnishing.

No. 16—An emulsifiable solvent that loosens and dissolves buffing and polishing compounds. Also effective as an emulsion cleaner for presoaking operations. Has quality rust inhibiting properties.

Everite—An inhibited acidic product for removal of heat scale and rust. Negligible attack on base metal with greatly reduced tendency for hydrogen embrittlement.

WHETHER YOU ARE A USER OF

SEYMOUR

ANODES

NOW OR NOT, YOU ARE WELCOME TO OUR LABORATORY SERVICE

If you are struggling with some sort of plating difficulty, such as slow corrosion, excessive sludge, peeling, porosity, brittle deposit, etc., our well-equipped laboratory and experienced staff will gladly lend a hand. In this laboratory, chemists are constantly making analyses and tests — working out short cuts wherever possible, and doing other things of present or potential value to the plating industry. Their experience is yours whenever you choose to make use of it.

A HANDY LIST OF SEYMOUR ANODES

99%+ *Rolled Depolarized* — A very fine, homogeneous, even-grained virtually pure nickel anode. Corrodes in hot or cold solutions with minimum metallic loss. Forms practically no sludge. Especially suitable for baths having a pH above 4.5 electrometric.

99%+ *Rolled Carbon* — A rolled anode of high efficiency for low pH hot Watts baths not above 4.5 electrometric. Corrodes smoothly with a minimum of loose nickel.

99%+ *Cast Carbon* — A pure nickel anode with carbon content adjusted for smooth, uniform corrosion without special controls. Available, however, with carbon content to meet any specifications. Adaptable for general shop work using hot or cold baths.

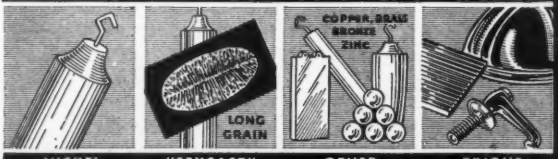
95-97% *Sand Cast* — Corrodes readily in solutions low in nickel or weak in salts — therefore suitable for cold, high pH, low current density plating solutions. Uniform corrosion throughout the life of this anode is obtained by an even distribution of the carbon content. A 90-92% Sand Cast Seymour Nickel Anode is also available.

"Seycast" — An improved type of 99%+ cast anode of very high efficiency designed primarily for Bright Nickel baths, but works perfectly in any hot Watts bath having a pH of 4.5 electrometric or lower. Corrodes evenly with practically no loose nickel formation, due to long, interlocking grains radiating from a common center. Especially suitable for high current densities.

Bright Nickel — A hot organic type process free from promoter metal, stable and easily controlled. Produces brilliant deposits from a standard hot nickel bath without the usual coloring or buffing. Excellent throwing power, wide operating conditions. Free from wetting out agents.

OTHER ANODES — Seymour Anodes in all shapes to meet rigid specifications are also available in copper, brass, bronze and zinc. The copper used is electrolytic. The zinc is always the best grade obtainable.

THE SEYMOUR MFG. CO., SEYMOUR, CONN.



INDUSTRY NEWS

Electrochemist Wanted

Electrochemist wanted to conduct research in electrolytic and chemical etching, electroplating (primarily upon light metal alloys) and electrophoretic deposition from latex and resin dispersions. Ph.D. or equivalent is desired, with research experience in electrochemistry. Excellent opportunity. Write today to Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio.

•

Movie on Use of Aluminum Available Free of Charge

"*Dateline Tomorrow*", a two-reel sound motion picture, is offered free of charge to any group interested.

Produced for *The Aluminum Company American* by the Jam Handy Organization, the picture visualizes and explains many new peacetime uses for aluminum, partially the result of wartime developments. It also reveals newest methods of fabricating the metal and getting many durable and novel finishes.

For free showing before interested groups, write to *D. B. Hobbs, The Aluminum Company of America, Pittsburgh, Pa.*

•

Additional Plant Purchased by Island Equipment Corporation

The Island Equipment Corporation, 101 Park Avenue, New York 17, N. Y., has announced the purchase of an additional plant in Hollis, Long Island, adjacent to Plant No. 1

Having a private railroad siding and a large floor area, this new plant is expected to greatly facilitate the production of the Company's *Roller Gravity* equipment. The Engineering and Detail offices have also been moved to the new site, while Plant No. 1 will now devote its facilities to *Power Conveying* equipment exclusively.

•

Opportunities for Supervisors

A leading national plating organization has an unusual opening in plant supervision for a technically trained man with sound practical experience in copper-nickel-chromium plating.

There are additional openings in the supervision of mechanical and polishing operations.

Send replies to MR—9A, THE MONTHLY REVIEW, P. O. Box 168, Jenkintown, Pa.

•

H-VW-M Issues Bulletin on Full Automatic Conveyors

A new Bulletin No. FA-102 has been issued by the *Hanson-Van Winkle-Munning Co.*, of Matawan, N. J., on full automatic electroplating conveyors.

This bulletin describes all of the full line of conveyors made by the Company, including the Elevator type, the Munning type, the Straight Line type, and a variety of special plating machines such as caustic cleaning lines, tin plating lines, machines for plating wire, cable, zippers, etc.

The bulletin is profusely illustrated with photographs and with phantom assembly drawings of the Elevator type and the Munning type conveyors.

Robert T. Sammet Joins Mitchell-Bradford Company

The Mitchell-Bradford Chemical Company, 2446 Main Street, Stratford P. O., Bridgeport, Connecticut, has announced the appointment of *Robert T. Sammet* as Director of Research.

Mr. Sammet is a graduate of Union College, Schenectady, with special graduate training at Syracuse University, and also the Institute of Paper Chemistry at Appleton, Wisconsin. He was employed by Crane & Company, Dalton, Massachusetts, as a Control and Research Chemist until the outbreak of the war. He spent three and one-half years in the Navy as a Lieutenant and upon his release the latter part of last year, became associated with The Mitchell-Bradford Chemical Company.

Mr. Sammet will assume the duties of supervising the development of new products and further improvement in the standard Mitchell-Bradford lines.

Porter Company Purchases American Spiral Spring

H. K. Porter Company, Inc., Pittsburgh 22, Pa., has announced the purchase of the business of the American Spiral Spring and Manufacturing Company of Pittsburgh. The new acquisition, together with the present Porter Fort Pitt Spring plant, will be operated as *American-Fort Pitt Spring Division* of H. K. Porter.

The new Porter expansion is in accordance with a previous established policy of developing the Company's railway supply and specialty business.

T. M. Evans, President of Porter, pointed out that the new acquisition not only expanded the Company's spring capacity, but also added a modern wire spring plant. It is anticipated that the joint operation of the two spring plants will provide substantial operating economies.

Porter and subsidiaries now operate seven plants, manufacturing products for railroads, processing industries and oil production.

FOR EVERY NEED

HARRISON **4-A** COMPOUNDS

QUALITY and UNIFORMITY

We will gladly send samples of any compounds we manufacture for

CUTTING—CUT AND COLOR—MIRROR FINISH

STAINLESS STEEL POLISHING COMPOUNDS

Double Header Compounds—Sizes 150–180–220–240–320
for Faster Cutting—Greater Economy

Ready for Use—CEMENT AND THINNER—Use Abrasive Cold

HARRISON & COMPANY, Inc.
HAVERHILL MASSACHUSETTS

Frederick C. Abbott Named to New Pennsalt Position

Frederick C. Abbott, formerly manager of the New Products Division, has been named Assistant Production Manager in the Manufacturing Department of the *Pennsylvania Salt Manufacturing Company*, it was announced recently.

Hugh Richard Bishop, recently released as a Lieutenant Colonel in the Air Forces after four years of service, has been named Manager of the New Products Division replacing Mr. Abbott. *Martin E. Johnson* has been transferred from the Market Research Department to the New Products Division.

Mr. Abbott, a graduate in Chemical Engineering from the University of Arkansas, came to Pennsalt from the Phosphate Mining Company in 1943 and previously was connected with the Ozark Chemical Company and the Texaco Salt Company. He was in the Market Research Department of Pennsalt before becoming Manager of the New Products Division.

Mr. Bishop graduated from Lehigh University and coached wrestling and taught physical education at the University of Pennsylvania before joining Pennsalt in 1939. He entered the Army in 1942.

Mr. Johnson, formerly with Rohm and Haas, joined the Market Research Department in 1945.

●

New Tenney Catalog Issued

Designated as *Catalog CD46*, an attractive 20-page catalog in color, on Cooling Units has been released by *Tenney Engineering, Inc.*, 26 Avenue B, Newark 5, N. J.

Among the items included are Tenney Unit Coolers and Kwik-Freeze Ice Makers, as well as sizes and prices, coil selection tables, formulae for determining coil sizes and other valuable engineering data, such as tables for determining air change load and heat leak load. Factors for use in calculating loads, and product storage load data for various commodities usually placed in cold storage are made available.

FOR SALE Available for Immediate Shipment

3—15,000/7500 AMPERE, 8/16 VOLT, **COLUMBIA ELECTRIC CO.** Motor Generator Sets. Separately Excited. Full Control Equipment. Write for full details.
4—5000/2500 AMPERE, 8/16 VOLT, **COLUMBIA ELECTRIC CO.** Motor Generator Sets. Separately Excited. Excellent Condition. Full Control Equipment.
1—5000/2500 AMPERE, 6/12 VOLT, **EAGER ELECTRIC COMPANY** Motor Generator Set. Separately Excited. Excellent Condition. Full Control Equipment.
1—4000/2000 AMPERE, 3/6 VOLT **HANSON & VAN WINKLE CO.** Motor Generator Set. Separately Excited. Excellent Condition. Full Control Equipment.
1—2500/1250 AMPERE, 6/12 VOLT, **HANSON & VAN WINKLE CO.** Motor Generator Set. Separately Excited. Full Control Equipment. Excellent Condition.
1—2000/1000 AMPERE, 6/12 VOLT, **CONNECTICUT DYNAMO AND MOTOR COMPANY** Motor Generator Set. Excellent Condition. Full Control Equipment.
1—1500/750 AMPERE, 6/12 VOLT, **IMPROVED AMERICAN GIANT** Motor Generator Set. INTERPOLE CONSTRUCTION. D.C. Motor. Excellent Condition. Full Control Equipment.
1—1500/750 AMPERE, 6/12 VOLT, **HANSON & VAN WINKLE CO.** Motor Generator Set. Excellent Condition. Full Control Equipment.
1—1000/500 AMPERE, 6/12 VOLT, **CONNECTICUT DYNAMO AND MOTOR CO.** Motor Generator Set. Full Control Equipment. Excellent Condition.
1—1000/500 AMPERE, 6/12 VOLT, **HANSON-VAN WINKLE-MUNNING CO.** Motor Generator Set. Full Control Equipment. Excellent Condition.
10—1000/500 AMPERE, 6/12 VOLT, **CHARLES J. BOGUE ELECTRIC CO.** Motor Generator Sets. Separately Excited. Full Control Equipment.

ANODIZING MOTOR GENERATOR SETS

1—1000 AMPERE, 50 VOLT, **CHANDEYSSON ELECTRIC CO.** SYNCHRONOUS-DRIVEN Motor Generator Set, complete with Exciter and Full Controlling Equipment.
1—500 AMPERE, 60 VOLT, **WESTINGHOUSE** Motor Generator Set, complete with Full Controlling Equipment.
2—500 AMPERE, 40 VOLT, **MOTOR GENERATOR CORPORATION** Motor Generator Sets. Excellent Condition. Full Controlling Equipment.
1—500 AMPERE, 24 VOLT, **HANSON & VAN WINKLE CO.** INTERPOLE TYPE Motor Generator Set. Excellent Condition. Full Controlling Equipment.

M. E. BAKER COMPANY 143 S'DNEY STREET CAMBRIDGE, MASS.

Waldo C. Hovey Becomes New Harshaw Vice-President

Waldo C. Hovey has been elected Vice-President in charge of Research and Development of *The Harshaw Chemical Company* according to an announcement by President *W. J. Harshaw.*

Mr. Hovey graduated from McGill University in 1916 in Chemical Engineering. From 1916–1925 he was connected with Shawinigan Chemicals Corporation as Superintendent. From 1925 to 1944 he was with Niacet Chemicals Corporation, Niagara Falls, New York, as General Manager. From 1944–1946 he was Manager of Plant Operations with Wyeth, Incorporated, Philadelphia.

●

R. T. Nalle on Pennsalt Board

Richard T. Nalle, of Philadelphia, Executive Vice-President of the Midvale Company, recently was elected to the Board of Directors of the *Pennsylvania Salt Manufacturing Company.*

Mr. Nalle, who is 57, succeeds John S. Jenks, who died last March 13. A graduate of the University of Pennsylvania with a degree of Electrical Engineer, Mr. Nalle is vice president and a member of the Board of the Franklin Institute of Philadelphia, a director of the Baldwin Locomotive Works, the Provident Trust Company and a director of the Executive Committee of Henry Disston and Sons, Inc.

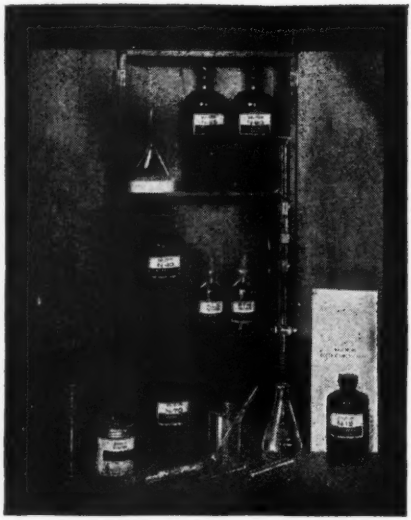
●

P. R. Mallory Develops Improved Rhodium Plating

The development of rhodium plating of an improved quality has been announced by *P. R. Mallory & Co., Inc.*, Indianapolis, Indiana.

It is claimed that it is now possible to obtain unusually heavy deposits, with the desirable hardness, brilliance and corrosion resistance inherent in metallic rhodium. At the same time, the improved Mallory process is said to assure freedom from shadows, pin holes and blisters which normally accompany heavier coatings.

Perfection of the rhodium plating process



CHROMIUM
NICKEL
COPPER

Simple test sets for aid in controlling plating and other solutions.

Write for literature.

KOCOUR CO.

4725 S. CHRISTIANA AVE.
CHICAGO 32, ILL.

Specify Kocour Sets from your supplier.

provides an enlarged field for this unusual metal in both the jewelry and industrial fields.

●

Mitchell-Bradford Chemical Company Re-Incorporated as of May 1

Mitchell-Bradford Chemical Company, 2446 Main Street, Stratford, Connecticut, manufacturers of "*Black Magic*" blackening processes, "*Silco*," a glass-base, sprayed and baked coating, and also heat treating materials, has reincorporated as *The Mitchell-Bradford Chemical Company*, as of May 1, 1946.

The officers of the corporation are *A. J. Mitchell*, President; *J. W. Mitchell*, Vice-President; and *M. F. Mitchell*, Secretary and Treasurer.

A. J. Mitchell has been active in the management and chemical research of the Company and is a founder of the original Company. He is the principal stockholder in the new corporation and will continue the active management of it.

Main offices and plant are located at Stratford, Connecticut. Mitchell-Bradford also maintains a mid-western office at Chicago, Illinois, under the supervision of *William H. Price, Jr.*, Mid-Western Regional Manager. The Company has warehouse stocks in Cleveland, Chicago, and San Francisco, with representatives spotted in strategic areas throughout the United States, Canada and in foreign countries.

●

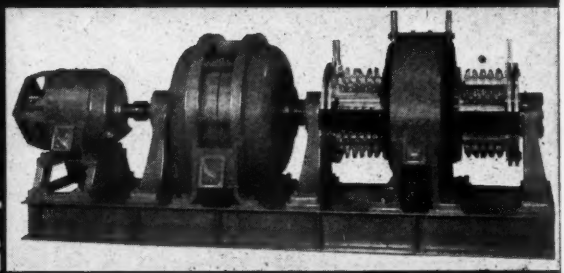
Pennsalt Acquires Fluorspar Mine in Salem, Kentucky

The Pennsylvania Salt Manufacturing Company recently announced it has purchased the Kentucky Babb Fluorspar Mine near Salem, Kentucky.

The mine and surface inventory were purchased from Roberts and Frazer, active in other fluorspar mining operations as the Kentucky Fluorspar Company. Pennsalt recently has completed underground explorations of the Kentucky Babb Mine but is not now producing from it.

Pennsalt, one of the largest wartime producers of hydrofluoric and anhydrous hydrofluoric acids, recently announced it is making elemental fluorine available commercially for the first time. The element is being sold only for experimental purposes at present.

COLUMBIA MOTOR GENERATORS



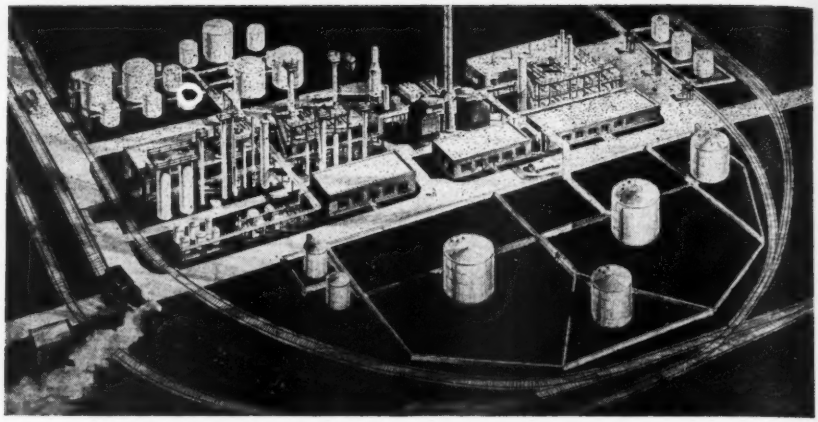
FOR ELECTRO-PLATING

Columbia Generators embody every feature essential for dependable, 24-hour operation. They are built for electroplating service in sizes of 6 to 20 volts, 500 to 20,000 amperes, for anodic treatment of aluminum in sizes of 40, 50, and 60 volts, 500 to 3,000 amperes. Columbia Generators for other electrolytic processes range from ½ to 250 KW, 100 to 40,000 amperes, 6 to 60 volts. Write for full information.

COLUMBIA ELECTRIC MFG. CO.

4519 HAMILTON AVE., N.E. CLEVELAND 14, OHIO

Chicago Office — 1525 E. 53rd St.



Sketch of Glycol Plant, part of Wyandotte Chemicals $25,000,000 Expansion Program

Wyandotte Chemicals Announces $25,000,000 Expansion Program

Wyandotte Chemicals Corporation will spend $25,000,000 in addition and enlargements to its present plants within the next eighteen months, it was announced by *E. M. Ford*, President.

The improvements will make Wyandotte, already one of the world's largest manufacturers of industrial inorganic chemicals and specialized cleaning materials, an important factor in the organic field.

One phase of Wyandotte's expansion in the organic field will be the erection of a

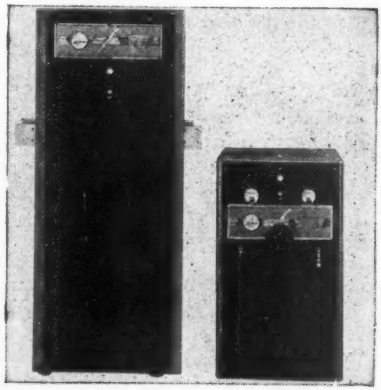
GET THE MOST WITH ELECTROPLATING! R-A VARIABLE PLATERS FOR EVERY USE

Left; Rectifier basic unit, no meters, no controls, no stepless variable auto transformer.

Units may be used without controls for applications where regulation of output is not necessary.

All basic units employ "on" and "off" control.

Meters may be incorporated into basic units if desired.



Right; Remote control unit with meters and stepless variable auto transformer immersed in oil to withstand acid fumes.

This last feature permits continuous control of output from no-load to full-load.

Use of remote control system allows various combinations of controls and units for difficult applications.

Combinations also for 12/6 volts, 18/9 volts, 250/500 amperes, 500/1000 amperes. Motor-driven remote controls for 1500 amperes and above. Write today for the R-A way—descriptive literature on a complete line of Custom-Built Rectification for your special applications.

Rectifier Division

RICHARDSON-ALLEN CORPORATION

15 West 20th St., New York 11, N. Y.

new synthetic detergent plant. Another organic unit representing an investment of several millions of dollars, and already under construction, will supply materials to the commercial chemical field.

In addition to the installation of these facilities for production of new products by Wyandotte, there will be new plants erected to increase production of chlorine, calcium carbonate and soda ash.

Improvements in the present method of producing caustic soda will also be a feature of the expansion program and will increase the output of this chemical.

Vitally important to the expansion program will be the installation of new facilities which will approximately double the present steam and power production.

Expansion of staff is proceeding hand in hand with plant enlargement. Important additions to personnel have been made in the J. B. Ford Division, headed by Vice-President *C. B. Robinson*, and the Michigan Alkali Division under Vice-President *Bert Cremers*. Technical Service, the department concerned with customer guidance in the use of industrial chemicals, has been expanded while Research and Development staffs, as well as the Engineering Department, have also been increased.

●

Special Chemicals Corporation Offers Series of Rectifiers

Special Chemicals Corporation announces the first in a series of selenium continuous rectifiers, with no back voltage, under the trade name of *Spectrifier*.

The *Spectrifier* is claimed to have the following specifications: full wave long-life selenium rectifier; input 110 volts, 60 cycles A. C., single phase; plugs directly into ordinary lighting circuit, draws 10 amperes; output 6 volts, 100 amperes; especially suited to chromium and rhodium plating. Can be used for all electroplating.

The other new products are the aluminum anodizing rack and nickel cyanide.

Further details can be obtained from Special Chemicals Corporation, 30 Irving Place, New York 3, N. Y.

WE HAVE ALL THE ANSWERS!

. . . For over fifty years, G. S. Blakeslee & Co. have been engineers of cleaning equipment. Many problems have been solved and many bottle-necks in the production line eliminated with Blakeslee Metal Parts Washers and Solvent Degreasers.

G. S. Blakeslee & Co. would appreciate the opportunity of giving you the information that will help solve your metal parts cleaning problems.

Write for free informative booklet.

BLAKESLEE
Solvent Vapor DEGREASERS
Metal Parts WASHERS

STANDARD AND SPECIALS Engineered for you

G. S. BLAKESLEE & CO., CHICAGO 50, ILLINOIS
NEW YORK, N. Y. TORONTO, ONT.

33D ANNUAL PROCEEDINGS

SOON AVAILABLE

COMPLETE VOLUME OF PAPERS AND DISCUSSION PRESENTED AT THE EDUCATIONAL SESSIONS OF THE 1946 ANNUAL CONVENTION INCLUDING . . .

Valuable information on Anodizing and Coloring of Magnesium Alloys, Preparation of Surfaces for Organic Coatings, Properties and Applications of newer Synthetic Organic Coatings, Polishing and Buffing Compounds, Copper, Nickel, and Continuous Strip Plating, and Reports on the Nine A. E. S. Research Projects.

PROBABLE PRICE PER COPY—$6.50

SEND YOUR ORDER, WITH CHECK, NOW FOR THE 33D ANNUAL PROCEEDINGS TO—

AMERICAN ELECTROPLATERS' SOCIETY
P. O. BOX 168 JENKINTOWN, PA.

E. Reed Burns Appoints Southern Representative

E. Reed Burns Manufacturing Corporation, with offices at 40 Withers Street, Brooklyn, New York, and plants in Brooklyn, N. Y., and Middlesex, New Jersey, announces the appointment of *Richmond B. Holmes*, of Baltimore, Maryland, as its Maryland and Southern representative.

Mr. Holmes was the owner of the Holmes Electroplating Works of Baltimore and has a thorough and wide experience in the operation of a plating and polishing plant and is familiar with the best methods of polishing and buffing.

Mr. Holmes has his offices at 2001 South Road, Baltimore, Maryland.

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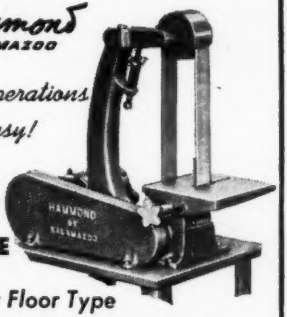
H-VW-M Adds to Sales Force

The Hanson-Van Winkle-Munning Co., Matawan, N. J., announces the appointment of two new sales representatives, *Wilfred G. Cryderman*, and *Howard L. Wright*.

Mr. Cryderman is a graduate of Michigan State College with the degree of Bachelor of Science in Mechanical Engineering. His previous business connection was with the Cleveland office of Westinghouse Electric Corp. Following a training course at Matawan, he has been assigned to the Dayton, Ohio, office of the H-VW-M Co.

Hammond of KALAMAZOO

"101" Operations Made Easy!



Model F-2 FLEXIBLE BELT
Bench or Floor Type

Grinding, Polishing, Deburring, Chamfering on irregular or regular shaped parts, also eliminate costly hand filing operations!

Hammond Machinery Builders INC
1613 DOUGLAS AVENUE • KALAMAZOO 54, MICHIGAN

ACID AND ALKALI PROOF LININGS AND MORTARS

•

ACID PROOF CONSTRUCTION

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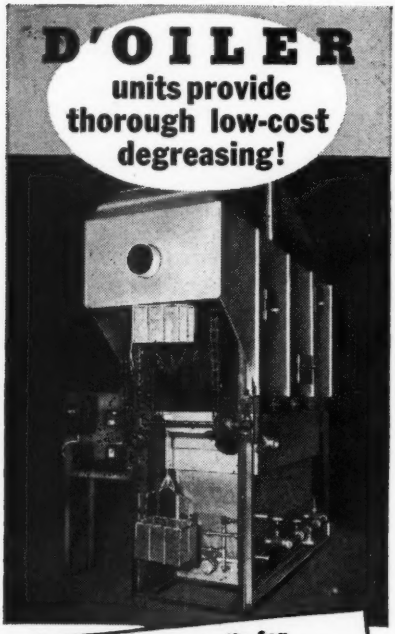
THE CEILCOTE CO.
Consulting and Research Engineers
750 ROCKEFELLER BLDG.
CLEVELAND, OHIO



If the job calls for a degreaser—there's a D'Oiler for the job!*

D'OILER engineers — pioneers in solvent degreasing and de-oiling—have developed a D'OILER model for every purpose . . . volume work and small batch dips, hand-operated or automatic, one dip or three dip, vapor spray machine or custom-built devices for special jobs. Illustrated above is a three dip automatic for batch degreasing of small parts.

Avoid the pitfalls of improper degreasing methods by getting the expert recommendations of our technical staff.

*There are metal cleaning problems which are solved by methods other than degreasing; we shall inform you frankly and thoroughly of the methods best suited to your operations.

Our long experience is ready to help you do a finer, faster cleaning job. For D'OILER information on your degreasing operation, WRITE TODAY.

Mechanical
PROCESS COMPANY
P. O. BOX 88, SOUTH ORANGE, N. J.

Howard L. Wright, who was recently discharged from the U. S. Navy, in which he served as a Lieutenant, has also taken an intensive field training course at the main office and plant of the Company in Matawan, N. J. He is a graduate of Franklin and Marshall College and holds the degree of Bachelor of Science in Economics, having specialized in sales and marketing. Mr. Wright has been assigned to the Philadelphia office of the Company.

•

New Electrical Parts Firm Opened in Sycamore, Illinois

Holub Industries, Inc., a new concern recently organized by *Bert E. Holub*, has begun the manufacture of electrical and mechanical products in its new plant at 413 DeKalb Avenue, Sycamore, Illinois.

Holub's new "HI" trademark appears on an extensive line of products, including industrial electric blowers, industrial vacuum cleaners, circuit and voltage testers, solderless and tapeless wire connectors, commutator stones, carbon brush seaters, commutator saws and milling cutters, fuse pullers, fuse clip clamps, fuse reducers, lathe live centers and copper wire strippers in hand types, foot operated and motor driven. These products are available through leading electrical wholesalers in all principal cities. Sales

engineers and their offices are located in large cities throughout the country.

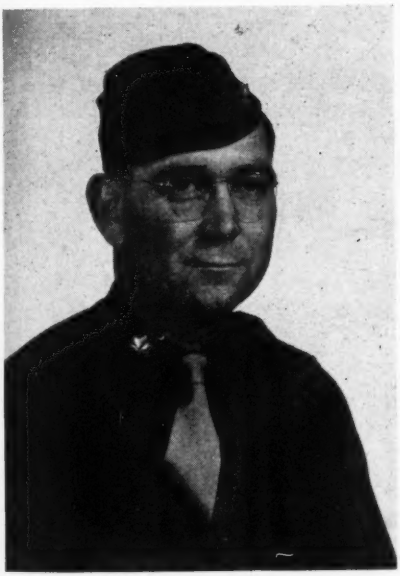
Holub Industries, Inc., is making arrangements for representation in important overseas markets.

Gordon W. Wetzel, formerly Mr. Holub's assistant at Ideal Industries, is Sales Manager of this new concern. Mr. Wetzel was recently released from the armed forces after 39 months service.

●

Dr. William L. McCracken Appointed to New Detrex Post

Detrex Corporation, Detroit, Michigan, has announced the appointment of *Dr. William L. McCracken*, recently discharged from the U. S. Army Engineers with the rank of Lieutenant Colonel, to the position of Administrative Assistant to *C. F. Dinley, Sr.*, Vice-President in charge of Research and Engineering.



Dr. McCracken's new duties, according to *A. O. Thalacker*, Vice-President and General Manager, will provide both administrative and technical assistance to Mr. Dinley in research and product development in all of the Company's three major divisions: industrial metal cleaning, dry cleaning, and oil-extraction.

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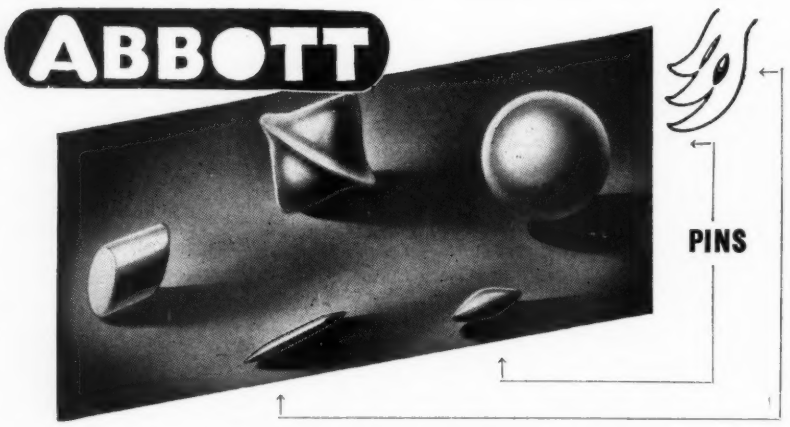

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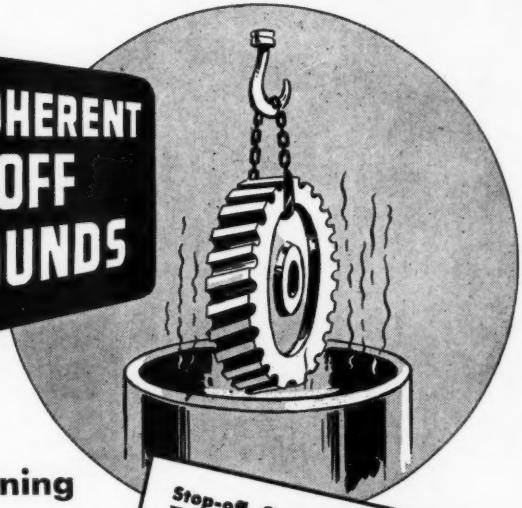

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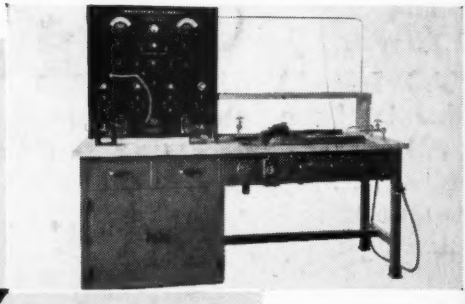

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